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TOPOGRAPHIC AND GEOLOGIC

ATLAS

of

PENNSYLVANIA

No. 27

PITTSBURGH QUADRANGLE

GEOLOGY AND MINERAL RESOURCES

By

MEREDITH E. JOHNSON

Department of Internal Affairs
Jas. F. Woodward, Secretary

Topographic and Geologic Survey
Geo. H. Ashley, State Geologist

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LETTER OF TRANSMITTAL.

James F. Woodward, Secretary,
Department of Internal Affairs.

Sir:—

I submit herewith manuscript and illustrations for a Topographic and Geologic Atlas of the Pittsburgh Quadrangle, by Meredith E. Johnson, to form part No. 27 of the Topographic and Geologic Atlas of Pennsylvania. Field work for this Atlas began in 1921 and was completed in 1925. During that time Mr. Johnson also completed the field work on the Greensburg Quadrangle and prepared the Atlas (No. 37).

This Atlas is purposely limited in scope to the topography, geology, and mineral resources of the area covered. It is recalled, however, that this report covers one of the most densely populated areas in Pennsylvania, and one of the most intensive industrial districts in the world, probably the most important as regards production of iron and steel and their products.

On the mineral resource side the area includes one of the earliest and later one of the most important mining centers in the United States, and has been the scene of large-scale bituminous coal mining for more than a century. Here also began the first extensive use of natural gas. The area includes the McKeesport gas pool prominent in the public eye in 1919-1920. Oil, gravel, clay, sandstone, and limestone are among its actual or potential resources. Salt making, from brine from drilled wells, was an early industry but is no longer active.

Looking to the future the Atlas points out that although the Pittsburgh coal has been mined in this area for 165 years and 75 per cent of the original deposit has been mined out or irretrievably lost, nevertheless there yet remains in this quadrangle probably 137,000,000 tons of coal in the Pittsburgh bed that will eventually be recovered. The Upper Freeport coal bed contains an original deposit of 569,000,000 tons in this quadrangle, a great reserve that has hardly been tapped.

The beds of limestone, clay, and sandstone are described and illustrated graphically. Analyses or tests made especially for this report are presented, as it is realized that future demand may

lead to the development of these dormant resources. To present such information as will be useful in the further development of the mineral resources is the primary purpose of the Atlas. For example, the maps showing the structure or lay of the rocks may guide future drilling for oil and gas. Other small gas pools will undoubtedly be found, and gas will be sought in the deeper sands not reached in the earlier drilling.

There is a cultural as well as economic use for these atlases. This Atlas should be of especial interest to the schools and colleges for teaching the history and resources of the area. The geologic history of the region during glacial time is of large interest as the physiography of the region was profoundly affected by the great ice sheet that laid down the extensive deposits of high-level gravel.

I recommend publication in the same form as Atlas Nos. 37, 65, 178, and 206, in edition of 5,000.

Respectfully submitted,

Geo. H. Ashley

State Geologist.

October 4, 1927.

PREFACE.

The Topographic and Geologic Atlas of Pennsylvania presents the results of the Survey's "thorough and extended survey of the State for the purpose of elucidating the geology and topography of the State." (Act of June 7, 1919, establishing Survey.)

The Act further provides: "The Survey shall disclose such chemical analysis and location of ores, coals, oils, clays, soils, fertilizing and other useful minerals, and of waters, as shall be necessary to afford the agricultural, mining, metallurgical, and other interests of the State, a clear insight into the character of its resources. The Survey shall also disclose the location and character of such rock formation as may be useful in the construction of highways or for any other purpose."

The results of the surveys may, in accordance with the provisions of the Act, be presented in the form of several series of publications as follows:

1. Topographic Atlas Sheets 16 by 20 inches: The surveys for these sheets are made by the State in cooperation with the U. S. Geological Survey, each paying half the costs. The engraving, printing and distributing of these sheets is done by the U. S. Geological Survey at Washington, D. C.

2. The Topographic and Geologic Atlas: Maps and texts showing and describing the topography, geology and mineral resources of the State by quadrangles. This series continues and supplements all "folios" and "economic bulletins" of Pennsylvania already published by the U. S. Geological Survey in cooperation with the State. Each quadrangle is an area about 17½ miles long from north to south and about 13½ miles wide from east to west and is represented by a single map or sheet. The quadrangles are numbered from west to east and from north to south. Sheet No. 27 is in the second row from the western edge, and is the seventh sheet from the northern boundary of the State. The reports constituting the atlas will bear the same numbers. Figure 1 shows the geographic position of the Pittsburgh Quadrangle, Sheet 27, and the extent of topographic and geologic mapping.

3. County Reports: As the Atlas Sheets and reports are highly detailed and somewhat technical, a series of County Reports will present the general facts in more popular language, and

on maps without topography. These reports will also review the broader aspects of the subject, and in particular will present the detailed Soil Maps and Soil Reports.

4. Mineral Resources: These reports are confined to describing and showing the location of a single mineral resource over the State, with studies of the technology, including the mining, preparation and marketing of the minerals.

5. Underground Water Resources: In general, water resources will be discussed in the County Reports or in the Topographic and Geologic Atlas, but general studies on underground water supplies will follow in a fifth series of reports.

6. Soil Reports: In general, Soil Maps and Reports will accompany the County Reports, but general maps or discussions on soil conditions will fall in this series.

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ILLUSTRATIONS

Airplane view of downtown Pittsburgh and confluence of Allegheny and Monongahela rivers.

GEOLOGY AND MINERAL RESOURCES
OF THE
PITTSBURGH QUADRANGLE, PENNSYLVANIA

By Meredith E. Johnson

INTRODUCTION.

In 1760, Captain Thomas Hutchins, who visited Fort Pitt (now Pittsburgh) in that year, found a coal mine opened on the opposite side of the Monongahela River, for the use of the resident garrison.[1] That was the beginning of an industry for which the Pittsburgh region has since become famous. The Pittsburgh quadrangle, including most of the city of Pittsburgh, is situated in the heart of Pennsylvania's bituminous coal fields and has contributed largely to the total quantity of coal mined. Because of its importance in the history of the coal industry, its importance as a source of petroleum and natural gas and other mineral resources, and more particularly, because of the interest which it was hoped a geological report would have for the many people living within the boundaries of the quadrangle, this area was one of the first selected by George H. Ashley, State Geologist, for detailed mapping when active field work was resumed under authority of the Legislature of 1919. Work was begun in the summer of 1921 by a party composed of O. G. Bell[2], C. G. Webb and the author; C. J. Campbell replaced Webb in the middle of the season. The author continued the field work in 1922, 1924 and 1925, working unaided in 1922 and 1924 and having the assistance of W. A. Copeland[3] in 1925.

PREVIOUS GEOLOGIC WORK.

Many geologists have measured sections, mapped the outcrop of the Pittsburgh coal bed, or done other geologic work in this quadrangle. H. D. Rogers[4] gave a detailed section and description of the outcropping rocks at Pittsburgh in his second report on the geology of Pennsylvania, published in 1858. The Pennsylvania Second Geological Survey continued his work, and in 1876, Stephenson's report[5] was published, including sections and descriptions of the geology in Union township, Washington County; and Snowden, Bald-

[1]d'Invilliers, E. V., Report on the Pittsburgh coal region: Pennsylvania Second Geol. Survey, Annual Report, 1886, Part I, p. 5, 1887.
[2]Instructor in geology, Cornell University.
[3]Instructor in geology and mineralogy, Carnegie Institute of Technology.
[4]Rogers, H. D., Geology of Pennsylvania, Vol. II, pp. 630-635, 1858.
[5]Stevenson, J. J., Report on progress in the Greene and Washington district of the bituminous coal fields of western Pennsylvania: Pennsylvania Second Geol. Survey, Vol. K., 1876.

win, Lower St. Clair, Jefferson, and Mifflin townships, Allegheny County—all of them in part at least within the boundaries of the Pittsburgh quadrangle. This was followed by a report[6] containing a description of the geology in Shaler, Indiana (including O'Hara), Ross and Reserve townships, Allegheny County and another report[7] containing descriptions of the geology in North Huntingdon and Sewickley townships, Westmoreland County, and Elizabeth, Versailles, Wilkins, Penn, Plum, and Patton townships, and the city of Pittsburgh in Allegheny County. A report[8] on the Pittsburgh coal region published in 1887 contained a geological map of that region and in the text brief descriptions of the geology and structure by townships were given. In later publications I. C. White[9] and Stevenson[10] gave additional sections of the strata in the Pittsburgh district with brief descriptions of some of the individual beds. In 1909 the Carnegie Museum published an article by Percy E. Raymond[11] in which a detailed section measured in the deep cut of the Pennsylvania Railroad, south of Trafford City is given. Other articles, long and short, have appeared; none of them however have given enough detailed stratigraphic sections to convey an adequate idea of the stratigraphy of the Pittsburgh quadrangle, nor have any of them given an accurate structure map or a detailed geologic map of that area. It is hoped that this volume will fill that need and, in addition, give a better conception of the economic resources of the Pittsburgh district.

LOCATION AND AREA.

The Pittsburgh quadrangle includes most of southeastern Allegheny County and a small part of western Westmoreland County, and a little bit of Washington County. It is a quadrangular area bounded by meridians 79° 45′ and 80° 00′ west, and parallels 40° 15′ and 40° 30′ north, the included area being approximately 227 square miles. Pittsburgh is in the northwest quarter of the quadrangle, McKeesport and Duquesne are near the middle, and Elizabeth is near the south boundary.

[6] White, I. C., Report of progress in the Beaver River district of the bituminous coal fields of western Pennsylvania: Pennsylvania Second Geol. Survey, Vol. Q, 1878.

[7] Stevenson, J. J., Report of progress in the Fayette and Westmoreland district of the bituminous coal fields of western Pennsylvania: Pennsylvania Second Geol. Survey, Vol. KK, 1878.

[8] d'Invilliers, E. V., Report on the Pittsburgh coal region: Pennsylvania Second Geol. Survey, Annual Report, 1886, Part 1, 1887.

[9] White, I. C., Stratigraphy of the bituminous coal fields of Pennsylvania, Ohio, and West Virginia: U. S. Geol. Survey Bull. 65, 1891.

[10] Stevenson, J. J., Carboniferous of the Appalachian basin: Geol. Soc. America, Bull, 1906-1907.

[11] Raymond, P. E., Some sections in the Conemaugh series between Pittsburgh and Latrobe, Pennsylvania: Annals of the Carnegie Museum, Vol. V, Nos. 2 and 3, 1909.

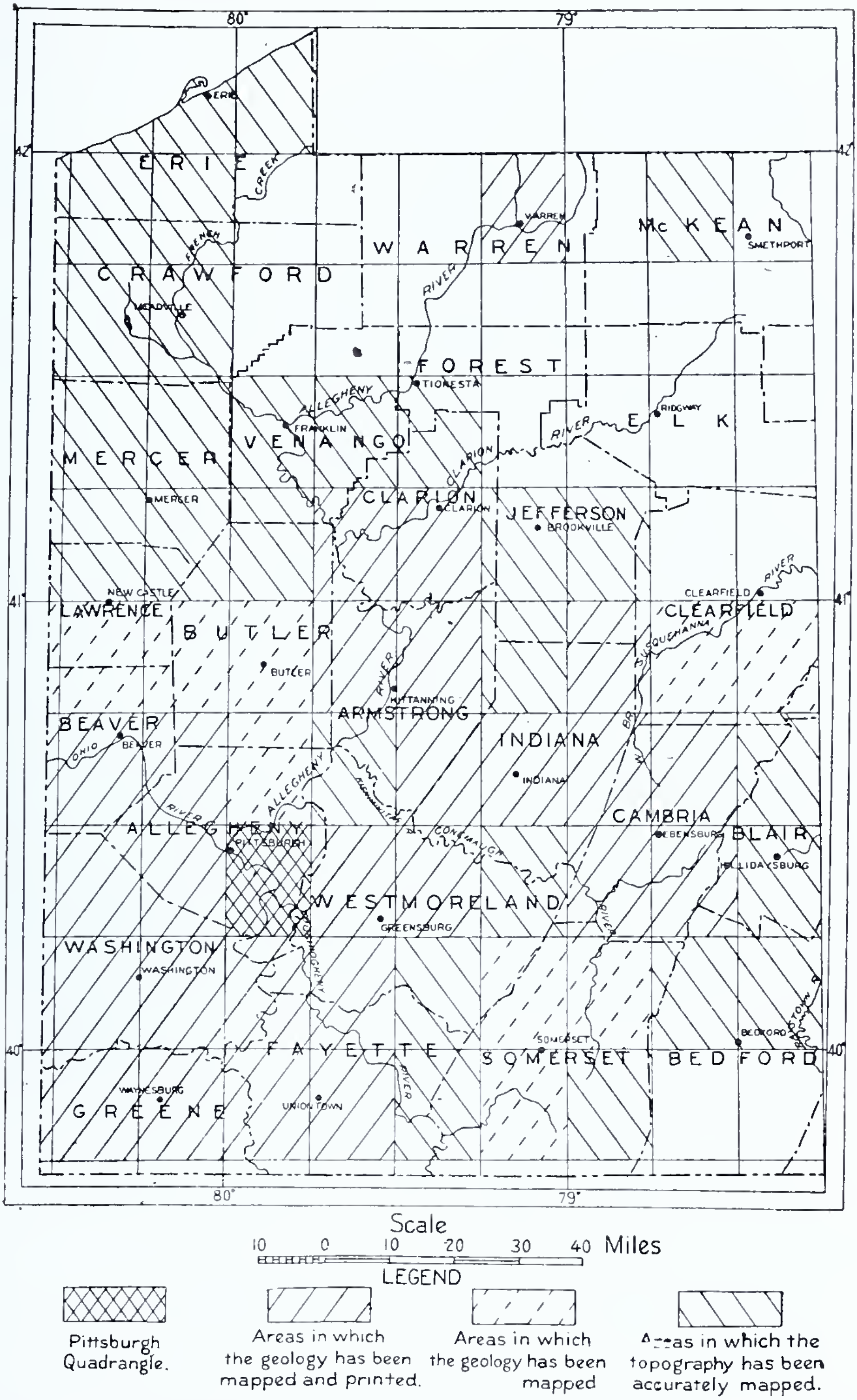


Figure 1. Index map of western Pennsylvania showing the location of the Pittsburgh quadrangle, and extent of topographic and geologic mapping.

ACKNOWLEDGMENTS.

Much of the material contained in this report relative to the development of the economic resources of the quadrangle could not have been obtained except through the kindness of the many individuals and companies approached for information. The list of those to whom the author is indebted is too long to give in detail, but the author's gratitude to some is too overwhelming not to mention them. The Peoples Natural Gas Company, Philadelphia Company, Carnegie Natural Gas Company, Greensboro Gas Company, Manufacturers Light and Heat Company, American Natural Gas Company, T. W. Phillips Gas and Oil Company, South Hills Oil and Gas Company and many smaller companies and operators gave willingly their oil and gas well data. The Pittsburgh Coal Company, Westmoreland Coal Company, Pittsburgh Terminal Coal Company, Bertha-Consumers Coal Company and others graciously permitted the author to make use of their mine data. And last, permission to copy and make use of the records of many diamond drill-holes was granted by many engineers and business men, including A. B. Coleman, John Rayburn, B. F. Hoffacker, W. H. Flint, D. R. Davis, E. M. Herr and others. These records were of inestimable value in making correlations and settling stratigraphic problems.

GEOGRAPHY.

TOPOGRAPHIC FEATURES.

Hills and Valleys.

Any stranger to Pittsburgh is at once impressed by the steepness of the hills; and if he should drive out into the country he would be equally impressed by some of the deep ravines leading down to the rivers and larger streams (See Plate VI, A). On the other hand some of the streams have begun to broaden their valleys and their gradient is only moderate. Such topography is typical of that stage of the erosional cycle known as "mature." It is intermediate between "young" topography, when the streams are cutting deep gorges with narrow valleys and the hilltops are broad and relatively flat, and "old" topography, when the valleys are broad and the hill-slopes are gentle.

The greatest relief, or difference in elevation of hilltops and adjacent valleys, is 555 feet and occurs along Monongahela River south of Belle Bridge and opposite Clairton. On a clear day the view from this vantage point is superb. The average relief in the quadrangle is about 300 feet. The smaller streams flow in every conceivable direction, the course of each stream being determined by the proximity of one of the deeply intrenched rivers.

Plate VI

A. Ravine type of topography in Pittsburgh.

B. Stream deposit on a high terrace, Pittsburgh.

PENEPLAINS.

The existence of peneplains in southwest Pennsylvania has been mentioned in many geologic reports describing that region. A peneplain (literally, almost a plain) is a land surface which has been reduced by ordinary processes of degradation approximately to a plain. It has slight relief and is near baselevel. The term is applied also to such a surface which has been uplifted to form a plateau and subsequently has been dissected. It is a striking fact that in some parts of western Pennsylvania the horizon viewed

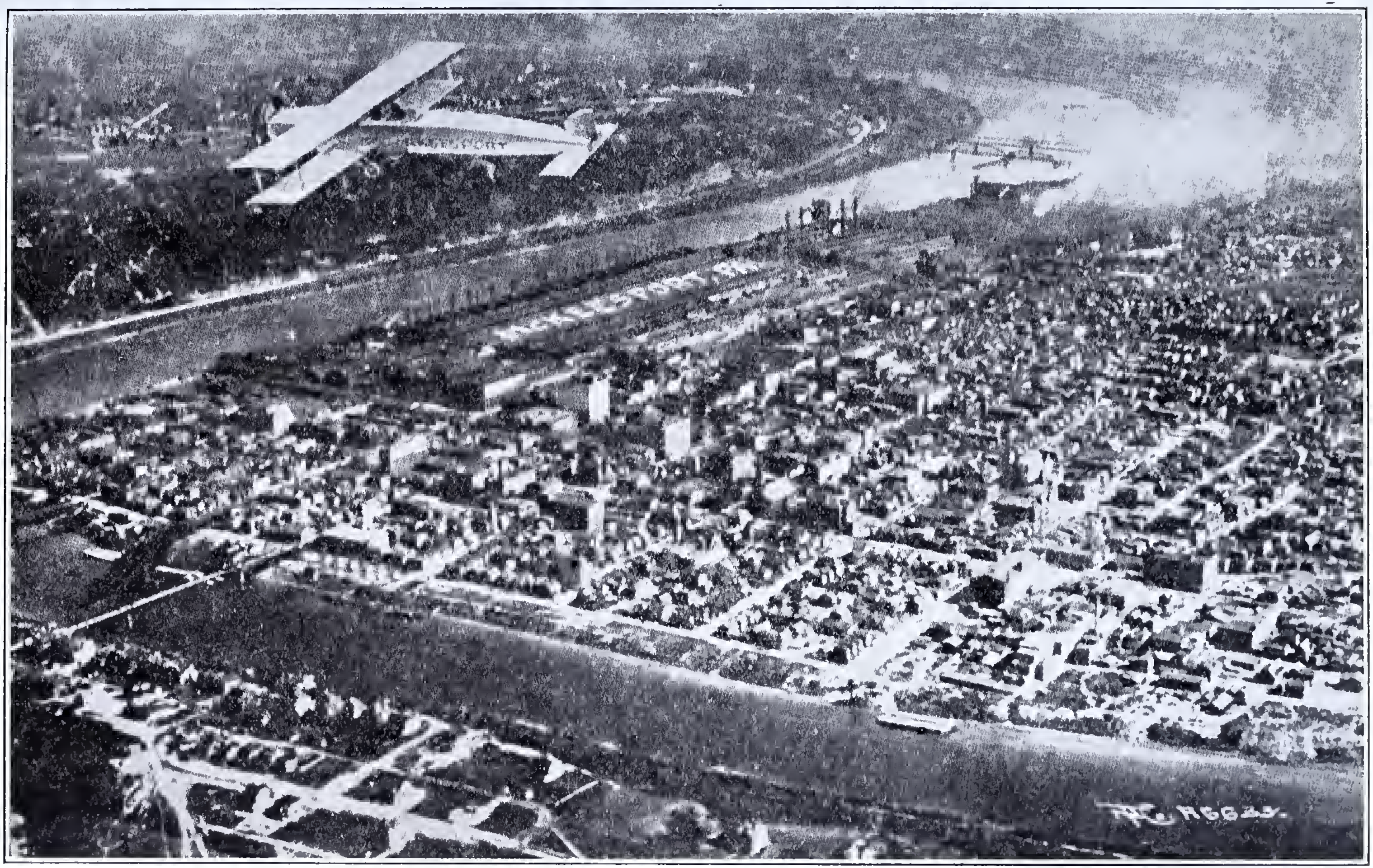
from the uplands is practically level and broad hilltops have practically the same elevation over considerable areas. In the Pittsburgh quadrangle the tops of many of the highest hills are now about 1250 feet above sea level. These are supposed to be the remnants of a greatly dissected plain which once was very extensively developed and was named the Harrisburg peneplain from its occurrence near the Capital of the State. It is possible also that the hilltops are not remnants of a former plain but are considerably below the level of a former plain which has been completely obliterated here.

It is evident that much time has elapsed since this peneplain was formed, for the gradual elevation of the former flat land surface, the development of the abandoned river channels now forming such a prominent feature of the topography around Pittsburgh, discussed shortly, and the eventual dissection of the peneplain to its present state, are all processes which proceed very slowly. According to the most conservative estimates it must have required over a million years to accomplish the results mentioned.

DRAINAGE.

Three large rivers, Allegheny, Monongahela, and Youghiogheny, flow through portions of the quadrangle, and a fourth, the Ohio, has its birth at Pittsburgh where the Monongahela and Allegheny unite. These rivers give the Pittsburgh quadrangle better water transportation than almost any other similar inland area. Both the Monongahela and Allegheny are navigable by river steamer and barge to points beyond the boundaries of the quadrangle, and the Ohio during most of the year is navigable all the way to the Mississippi. Years ago the lower portion of the Youghiogheny was navigable from McKeesport to West Newton; but the dams which made navigation possible were destroyed in 1865 and since then the river has not been navigable.

About one-sixth of the total area of the quadrangle, all of it near the northern boundary, drains into Allegheny River. Another sixth, or perhaps a little more, is drained by the Youghiogheny in the southeast. The remainder of the quadrangle is drained by the Monongahela and its tributaries. The network of small streams between the larger ones adequately drains all of the upland areas so that even heavy rainfalls are quickly disposed of. The valleys present more of a problem however, for heavy rains sometimes swell the streams until they overflow their banks. In recent years embankments and walls have been built which have partly rectified the situation at points where formerly the most damage was done; but still there is room for improvement. In past years the flooding of Turtle Creek



An airplane view of McKeesport which shows the Youghiogheny joining the Monongahela just above the huge plant of the National Tube Works.

(borough) and East Pittsburgh caused extensive damage[12]. In 1907, damage estimated at $530,000 was done by the flooding of the plants and towns between Wilmerding and East Pittsburgh; and in 1911 and 1912 the damage from floods is estimated to have been $100,000 and $75,000.

In Pittsburgh the losses have been even greater.[13] The flood of March 15, 1907, caused damage estimated at $5,259,500; that of February 16, 1908, damage of $839,800; and that of March 20, 1908, damage of $414,700. In spite of the extensive losses from floods in Pittsburgh in 1913, a proposed bond issue of $900,000 for building a protective wall along the river front was defeated at the polls.

Study of the topographic map shows little relation between the direction of stream flow and the rock structure; in fact, several of the larger streams cut directly across the structure. The obvious deductions are that the direction of stream flow was determined prior to the development of the present hills and valleys, and that these features formed slowly enough to permit the streams to cut down through the geologic structure revealed by erosion.

ABANDONED STREAM CHANNELS.

Perhaps the most striking feature of the topography in the Pittsburgh district is the broad flat valleys upon which much of the residential portion of the city of Pittsburgh is built. It takes little imagination to see that they represent abandoned stream channels (See Plate IX), and conclusive evidence to that effect is given by the extensive sand and gravel deposits of river origin which nearly everywhere cover the floors of the old channels (Plate VI. B). Leverett[14] and others have shown definitely that these channels were developed in pre-glacial times and subsequent to the formation of the Harrisburg peneplain. During that period the land mass which is now western Pennsylvania was slowly raised several hundred feet. From the evidence afforded by the oxbows and sweeping curves of the old channels we may infer that the rise of the land mass was not continuous, but that there were periods of relatively no movement during which the streams were able to cut down their channels until their gradients became very low and their flow very sluggish. The elevation at which the gently sloping land surface stood when the broad channel was developed in what is now East Liberty is undetermined.

[12]Turtle Creek Investigation: Water Sup. Com. of Pennsylvania, Water Resources Inventory Report, Part II, p. 41, 1916.
[13]Floods: Water Sup. Com. of Pennsylvania, Water Resources Inventory Report, Part VIII, p. 101, 1917.
[14]Leverett, Frank, Glacial formations and drainage features: U. S. Geol. Survey, Mon. 41, 1902.

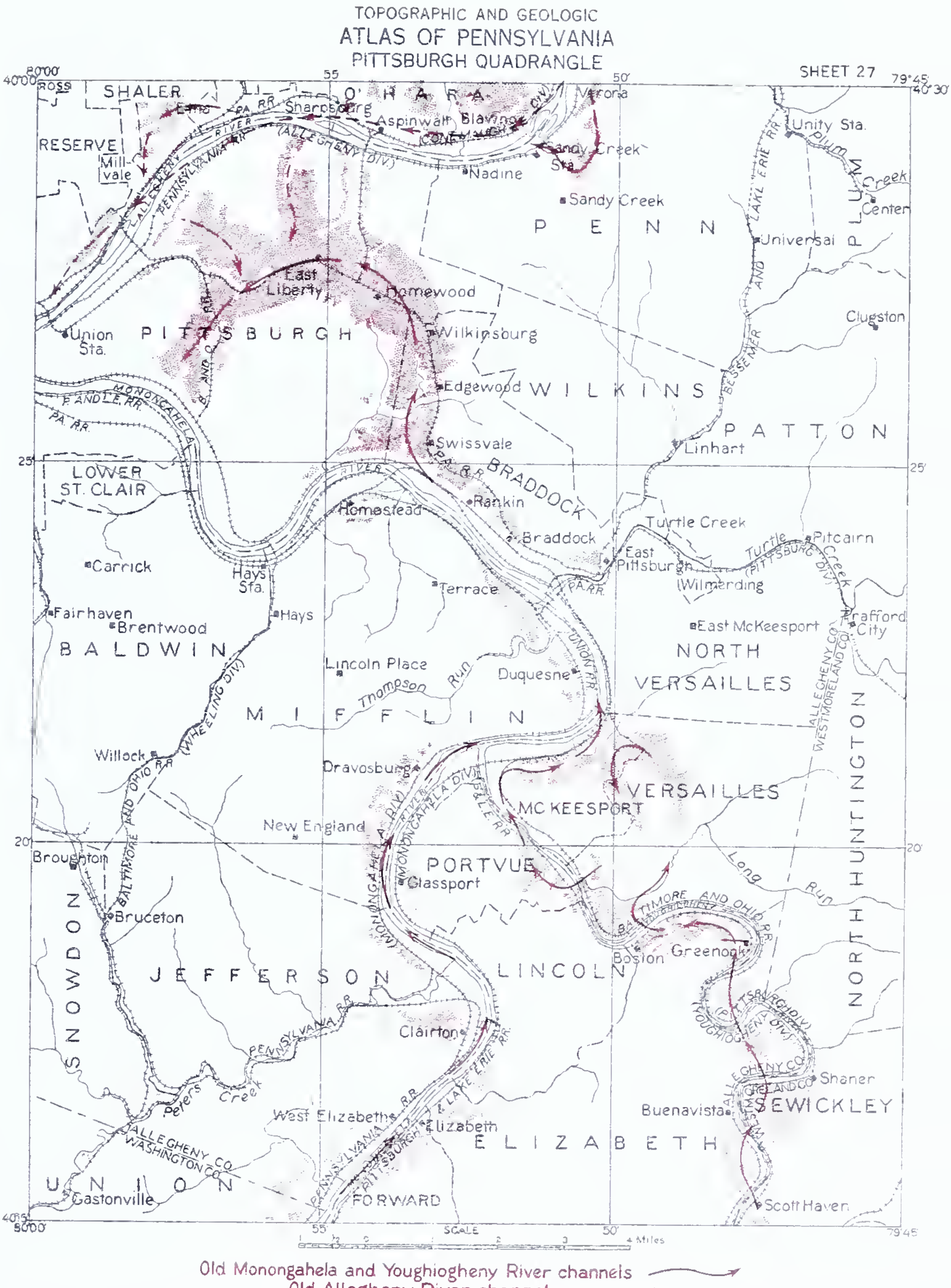


PLATE VIII. MAP SHOWING STREAM DEPOSITS OF GLACIAL AGE AND INDICATED DIRECTION OF FLOW OF RIVERS IN ABANDONED CHANNELS.

PLATE IX

View of old river channel from Schenley Park

Since the streams were even then well entrenched in the rising land mass, the question arises, how and why were they forced into the channels in which they flow today. An explanation of the filled and abandoned channels of Monongahela River is given by Frank Leverett[15]. He finds that Allegheny River was so heavily loaded with glacial material that it aggraded its channel at least 120 feet. Evidence of this is seen in the gravel deposits extending from 900 to 1020 feet above sea level. This thick deposit of sand and gravel in the channel below Pittsburgh ponded the Monongahela and caused it to aggrade its channel. Subsequently when the glacier melted and the land rose with respect to sea level, the streams were revived and deepened their channels, abandoning them in some places, and leaving the gravels of the period of glacial ponding high above the present channel. This explanation accords with observable facts.

In discussing the flow of the Monongahela and Allegheny in glacial times, Leverett[16] assumed that the old Monongahela flowed over the present site of Swissvale, through a course now occupied by Edgewood, Wilkinsburg, Homewood and East Liberty, and back to its present course by way of the channel between Oakland Cemetery

[15]Leverett, Frank, Personal communication.

[16]Leverett, Frank, Glacial formations and drainage features: U. S. Geol. Survey, Mon. 41, p. 145, 1902.

and Schenley Park. He further stated that "—— There are, however, three gaps in the chain of hills which were sufficiently low to permit the waters of the Allegheny River to enter the old oxbow of the Monongahela and bring into it a heavy deposit of glacial gravel. The easternmost gap is along Negley Run, immediately north of East Liberty, and has a width of nearly one-half mile. The middle gap is along Haights Run, less than a mile west of Negley Run. This gap is scarcely more than one-fourth mile in width. The third or westernmost gap sets in at Allegheny cemetery and extends westward to the base of Herron Hill, being nearly a mile in width. These gaps were filled by glacial gravel to a height of about 75 feet above the rock floor of the old oxbow of the Monongahela, their highest points being 970 to 975 feet above tide, as determined by Jillson with Locke level. The gravel extends but little into the old channel of the Monongahela, a feature which seems to indicate that the gravel-bearing water from the Allegheny there encountered a lagoon with but little current."

The direction of flow of the old stream is shown in Plate VIII. Mr. Leverett, glaciologist of the U. S. Geological Survey, studied this problem again in the summer of 1926 and found abundant evidence that the Allegheny River in glacial time followed its present course across the Pittsburgh quadrangle but at a higher elevation. That its channel was filled over 100 feet with sand and gravel is shown by the deposits now found on terraces on both sides of the present course; that the Allegheny spilled over to the south is shown by glacial gravels south of Allegheny cemetery and west of Highland Park. Mr. Leverett believes that there was a spillway to the south at the head of Negley Run, but the writer failed to find any pebbles of igneous rock such as are commonly found in Allegheny River gravels in this locality. These spillways were minor features, the main volume of Allegheny River following the present course.

The fact that a line drawn south from the east side of Allegheny cemetery roughly marks the eastern extent of Allegheny River gravel and the western extent of Monongahela River gravel in the abandoned channel at that point is evidence of slack water here and that this was not a through channel.

Since the ground in the downtown part of Pittsburgh is now completely hidden by paved streets and buildings, it is interesting to read in a report on "River Terraces in and near Pittsburgh," written by B. C. Jillson in 1893, that: "The business part of Pittsburgh stands on a terrace composed of sand and gravel, all of which was brought down the Allegheny River. This terrace is nearly a mile wide and extends from the Monongahela to Lawrenceville. The site of Birmingham (South Side, Pittsburgh) is formed

of clay brought down the Monongahela, consolidating into "hard pan", impenetrable to moisture, and thus differing totally from the loose sand and gravel brought down the Allegheny."

Probably the old Monongahela channel from Braddock to Lock No. 3 was approximately in the same place as the present channel. The old Youghiogheny may have joined the Monongahela below McKeesport instead of above, for a broad flat on the east side of McKeesport and about 200 feet above the river is covered with a river deposit.

The writer believes that the Youghiogheny formerly flowed northeast from Versailles up the present valley of Long Run to the mouth of Jacks Run and thence northwest, making a loop back down Snake Hollow to Christy Park at the north end of Versailles.

TRANSPORTATION.

Pittsburgh has splendid facilities for transportation both by water and by rail. Every large stream in the quadrangle is bordered by a railroad, each of the three rivers having railroads on both banks. The main line of the Pennsylvania Railroad crosses the quadrangle from east to west, and divisions of the Pennsylvania follow up both banks of the Allegheny and up the west shore of the Monongahela. The main line of the Baltimore & Ohio Railroad follows the east bank of the Monongahela as far as McKeesport, and from there on south, the east bank of the Youghiogheny. The Wheeling division of the same railroad follows up Streets Run, down Lick Run to Peters Creek and up that stream to beyond the borders of the quadrangle. The western division turns north between Schenley Park and Oakland district, Pittsburgh, and follows up Pine Creek. The Pittsburgh & Lake Erie Railroad, subsidiary of the New York Central, follows the west shore of the Monongahela from Pittsburgh to Homestead, crosses the river there, and continues along the east shore. A branch of the Pittsburgh & Lake Erie follows the west shore of the Youghiogheny from McKeesport south. The Bessemer & Lake Erie Railroad, chiefly a freight line, operates from Bessemer to the north, following the easy grade and fairly direct route afforded by Thompson Run. The West Side Belt Line, Montour Railroad and Union Railroad are exclusively freight lines and serve many of the coal mines and steel mills of the district.

The Pittsburgh Railways Company provides efficient and frequent trolley service in the city of Pittsburgh, and in addition provides rapid transportation between the city and its suburbs. The West Penn Company operates a trolley service between McKeesport and Irwin, between McKeesport, Buenavista and Frank, and from Traf-

ford City to Iwrin and nearby communities. Local trolley companies operate lines from Homestead to Lincoln Place, from Duquesne station to the top of the hill upon which Duquesne is built, and in Clairton, The Pittsburgh, Harmony, Butler and New Castle Railway and the Pittsburgh and Butler Street Railway provide fast interurban service to the communities indicated and to intermediate points.

A recent development in transportation in the Pittsburgh district is that caused by the building of a network of good, hard-surfaced roads, and the development of reliable, comfortable and speedy motor-busses. Bus lines now operate on regular schedules over many of the boulevards and "through roads" and afford quick transportation to many residents in outlying districts who in years past looked upon a trip to the nearest city as an event. Needless to state the shopping districts of Pittsburgh and McKeesport, the cities chiefly involved, have benefited enormously as the natural results of their increased trade from this source, and from the added multitude of customers who use their own cars to drive to the cities.

At the present time three main highways converge at Pittsburgh: the William Penn, Lincoln and a north-south highway, the William Flinn. A constantly increasing amount of freight is transported by motor-truck over these highways. In the past the Lincoln Highway had to carry the brunt of the heavy east-west traffic but the completion of the William Penn Highway has relieved the former of the congestion of traffic which at times almost blocked it and has provided the touring motorists with a new route of great interest and beauty.

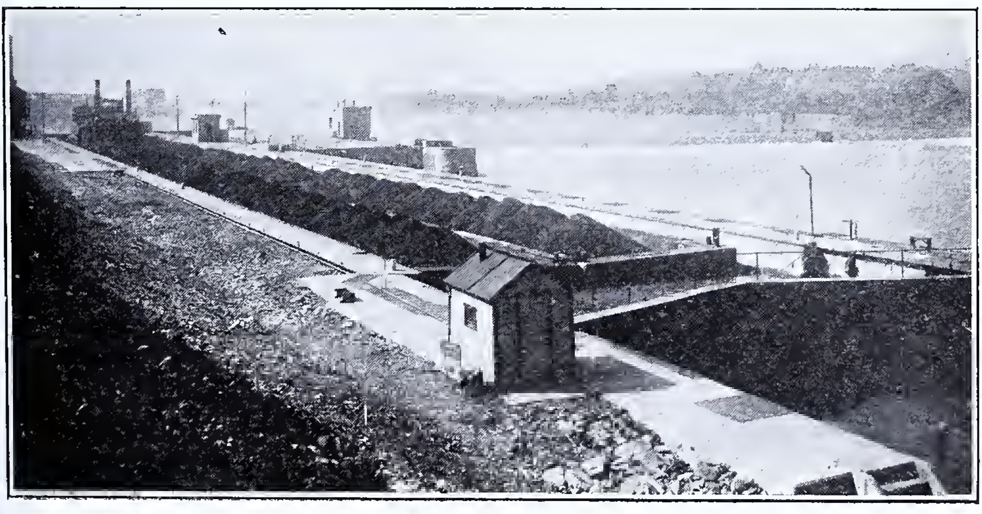
Although Pittsburgh is served by a network of railroads, the present high freight rates have caused renewed interest in the possibility of shipments by water. The Allegheny and Monongahela Rivers are navigable because of dams built by the United States Government (See Plate X). Recently many barges have been built (and many more are under construction) for the primary purpose of shipping steel to points in the Ohio and Mississippi Valley. Some idea of the magnitude of river shipments is given by the following figures in a letter from the Secretary, Traffic Division, Chamber of Commerce of Pittsburgh, March 5, 1926.

River Tonnage of the Pittsburgh District

	Allegheny	*Monongahela*	*Ohio*	*Total*
1913	2,159,630	12,039,175	4,033,685	18,232,490
1914	1,945,586	10,373,969	4,282,106	17,601,661
1915	1,899,654	11,815,085	4,814,517	18,529,256
1916	2,373,336	12,875,673	2,882,562	18,131,571
1817	2,300,143	16,009,133	2,887,717	21,196,993
1918	2,287,916	16,537,746	4,571,935	23,397,597
1919	2,058,069	17,137,501	4,017,089	23,212,659
1920	4,948,276	24,264,354	4,733,620	33,946,250
1921	3,737,441	16,100,824	2,340,578	22,178,843
1922	3,948,176	14,407,129	4,912,387	23,267,692
1923	4,612,640	23,560,024	7,286,005	35,458,669
1924	4,339,511	21,878,815	7,450,916	33,669,242
1925	4,744,843	23,716,121	7,729,215	36,190,179

Plate X

A. Lock No. 2, Monongahela River, above Braddock.



B. Lock No. 3, Monongahela River; barges with 6,000 tons of coal.

The distribution of freight in 1925 on the Allegheny, Monongahela, and Ohio rivers, according to reports of the U. S. Engineers Office, Pittsburgh, dated April 23 and 25, 1926, was as follows:

Freight transported by river boats in 1925, in tons.

Commodity	Allegheny[a] River	Monongahela River	Ohio[b] River
Coal	915,255	18,697,832	4,087,878
Coke	92,268	892,851	396,812
Cement	9,084	30,151	1,600
Sand and gravel	3,443,209	2,591,916	2,648,396
Stone	22,136	2,100	15,975
Iron and steel	16,499	548,840	463,107
Oil and gasoline	10,510	14,389	24,652
Logs and lumber	7,394	18,015	6,522
Packet freight		53,807	57,846
Unclassified	228,488	866,220	26,427
	4,744,843	23,716,121	7,729,215

a From Pittsburgh to Natrona, Pa.
b From Pittsburgh to Lock and Dam No. 11, near Beach Bottom, W. Va.

The Federal government has assured Pittsburgh interests that within four years the Ohio River will be completely canalized and already steps have been taken for building proper terminal facilities along the city's waterfront. The Lake Erie and Ohio River canal project, which would give Pittsburgh direct water transportation to cities on the Great Lakes by way of Ohio River, Beaver River, Mahoning River and a canal not yet constructed, would give Pittsburgh manufacturers an even greater market than the extensive one they now possess. It is quite possible that this project will be pushed to completion within the next few years. The value of cheap water transportation to a district which consumes large tonnages of raw materials and ships thousands of tons of finished products every day is difficult to overemphasize.

POPULATION.

Pittsburgh, the largest city in the quadrangle, had in 1920 a population of 588,343, and in 1925 an estimated population of 631,563. During the recent Special Session of the Pennsylvania Legislature (February, 1926), a bill to consolidate "the county poor districts, cities, boroughs and townships of the county of Allegheny" into one municipal corporation to be known as the City of Pittsburgh, was

introduced and passed. Should this measure be passed again at the regular biennial session of the legislature in 1927, and ratified by the people of the State in 1928, it would make Pittsburgh the fourth largest city in the land, with an estimated population of 1,600,000. Pittsburgh's growth up to the present time has been due to increased density of population, rather than through acquisition of adjacent communities. The following table, compiled from U. S. Census Bureau figures, illustrates Pittsburgh's rapid growth.

Increase of population in Pittsburgh.

Year	Population	Increase over preceding census
1925	631,563 (est.)	43,220
1920	588,343	54,438
1910	533,905	82,393
1900	451,512	107,608
1890	343,904	108,833
1880	235,071	95,815
1870	139,256	61,333
1850	67,863	36,659
1800	1,565	

McKeesport, situated at the junction of Youghiogheny and Monongahela rivers, is the second largest city in the quadrangle and had a population of 46,781, in 1920. In 1925 the estimated population was 49,097. Most of the city's growth occurred in the twenty year period from 1880 to 1900, during which time the National Tube Company was developing rapidly. Other cities and boroughs which had a population of 5000 or more in 1920 are:

Population of smaller cities and boroughs.

	1920	1925 (est.)
Wilkinsburg borough	24,403	27,392
Braddock borough	20,879	21,739
Homestead borough	20,452	21,437
Duquesne city	19,011	20,870
North Braddock borough	14,928	16,685
Swissvale borough	10,908	12,905
Carrick borough	10,504	12,989
Sharpsburg borough	8,921	9,198
Turtle Creek borough	8,138	9,270
Millvale borough	8,031	8,091
Rankin borough	7,301	
Knoxville borough	7,201	

Population of smaller cities and boroughs.—Continued.

	1920	1925 (est.)
Glassport borough	6,959	
St. Clair borough	6,585	
Etna	6,341	
Wilmerding borough	6,441	
Munhall borough	6,418	
East Pittsburgh borough	6,527	
Clairton borough	6,264	14,869
Pitcairn borough	5,738	
Mount Oliver borough	5,575	

From the above long list it is apparent that the Pittsburgh quadrangle is thickly populated and it may be imagined that mapping the geology of such a territory involved many unusual difficulties.

STRATIGRAPHY.

All of the rocks in the Pittsburgh quadrangle are of sedimentary origin, except the igneous rocks in the glacial deposits. The surface rocks belong chiefly in the Monongahela and Conemaugh groups of the Pennsylvanian system. Small patches of Permian rock, alluvium, and the terrace gravels, constitute the remainder. Sandstone and shale are the predominating kinds of rock, although beds of limestone, clay, and coal are fairly frequent. The exposed thickness of consolidated rock is 1,010 feet and it extends from the Buffalo sandstone in the Conemaugh to above the Waynesburg "A" coal.

The extreme variability of the members composing the groups of the Carboniferous in western Pennsylvania has previously been emphasized in other geologic reports dealing with that region. Because of this feature no attempt has been made in this report to draw one columnar section to represent the stratigraphy of the whole area. Instead, many local sections are given and it is hoped that from these sections the reader may obtain a better conception of the stratigraphy than has heretofore been possible. The following classification of rocks outcropping in the Pittsburgh quadrangle, or which were penetrated by drill holes, is that adopted by the Topographic and Geologic Survey of Pennsylvania for southwest Pennsylvania.

GEOLOGICAL COLUMN

SYSTEM	SERIES	GROUP	MEMBER	PROMINENT BEDS
QUATERNARY		Recent		Alluvium
		Pleistocene		Later glacial gravels Early glacial gravels
PERMIAN	DUNKARD	Greene		Lacking in Pittsburgh quadrangle
		Washington		Upper part lacking in this area Limestone, Colvin Run Coal, Waynesburg A. Limestone, Mount Morris Sandstone, Waynesburg
PENNSYLVANIAN	PITTSBURGH	Monongahela	Waynesburg	Coal, Waynesburg Sandstone, Brownsville Coal, Little Waynesburg Limestone, Waynesburg
			Uniontown	Sandstone, Uniontown Coal, Uniontown Limestone, Uniontown
			Sewickley	Limestone, Benwood Coal, Sewickley, Mapletown
			Redstone	Limestone, Fishpot Coal, Redstone, Pomeroy Limestone, Redstone
			Pittsburgh	Sandstone, Pittsburgh Coal, Pittsburgh
		Conemaugh	Little Pittsburgh	Sandstone, Lower Pittsburgh Coal, Little Pittsburgh Limestone, Pittsburgh
			Connellsville	Sandstone, Connellsville Coal, Franklin, lacking here
			Lonaconing	Lacking in this area
			Morgantown	Limestone, red beds, and coal, Clarksburg Sandstone, red beds, Morgantown Coal, Wellersburg
			Barton	Sandstone and coal, Barton, lacking
			Grafton	Red beds, etc., Birmingham Coal and limestone, Duquesne Sandstone, Grafton Limestone, Ames Coal, Harlem
			Saltsburg	Red beds, Pittsburgh Sandstone, Saltsburg Coal, Bakerstown Limestone, Cambridge, Woods Run Coal, Thomas, Wilgus, Bakerstown
			Buffalo	Limestone, Pine Creek Sandstone, Buffalo Limestone, Brush Creek Coal, red beds, Brush Creek
			Mahoning	Sandstone and coal, Mahoning Iron ore, Johnstown Red beds and limestone, Mahoning Coal, Piedmont and Upper Freeport rider

SYSTEM	SERIES	GROUP	MEMBER	PROMINENT BEDS
PENNSYLVANIAN (Cont'd)	PITTSBURGH (Cont'd.)	Allegheny	Freeport	Coal, clay, and limestone, Upper Freeport Flint clay, Bolivar Sandstone, Butler Coal, clay, and limestone, Lower Freeport Sandstone, Freeport
			Kittanning	Coal and clay, Upper Kittanning Coal and clay, Middle Kittanning Coal and clay, Lower Kittanning
			Clarion	Flint clay, Clarion Iron ore, Buhrstone Limestone, Vanport Sandstone and 2 coals, Clarion Coal and clay, Brookville
	POTTSVILLE	Upper Kanawha	Homewood	Sandstone, coal, and shale, Homewood
			Mercer	Coal and limestone, Upper Mercer Coal and limestone, Middle Mercer Coal and limestone, Lower Mercer
		Middle Kanawha	Connoquenessing	Sandstone and shale, Upper Connoquenessing Coal, Quakertown Sandstone, Lower Connoquenessing
			Sharon	Coal, Sharon
		Lower Kanawha		Sandstone, Olean, Sharon Unconformity
		New River Pocahontas		Lacking in Western Pennsylvania
MISSISSIPPIAN	MAUCH CHUNK			Red beds, Mauch Chunk, thin or lacking in Western Pennsylvania
	MERAMEC	Ste. Genevieve		Limestone, Loyalhanna
		St. Louis Warsaw		Lacking in Pennsylvania
	WAVERLY POCONO	Keokuk		Lacking in Pennsylvania
		Burlington		Sandstone, Burgoon Shale, sandstone, and limestone, Cuyahoga
		Kinderhook		Sandstone, Berea, First (?) sand
DEVONIAN	UPPER DEVONIAN	Venango-Catskill		Second, Murrysville, Hundred-foot, Gantz, Fifty-foot sands Third, Salamanca (?), Fourth sands
		Chemung		Fifth, Sixth, Elizabeth sands Warren sands Speechley, Tiona, Gartland sands Sheffield, Bradford sands
		Portage		Smethport, Kane, Elk group sands

SYSTEM	SERIES	GROUP	MEMBER	PROMINENT BEDS
DEVONIAN	MIDDLE DEVONIAN	Genesee Hamilton Marcellus		
	LOWER DEVONIAN	Onondaga Oriskany Helderberg		Limestone, Corniferous Sandstone, Oriskany Limestone, Helderberg
SILURIAN	CAYUGA			
	NIAGARA			
	MEDINA			Sandstone, Medina

The rocks will be described in descending order, the youngest first, each division recognizable in the field being described separately.

SURFACE ROCKS.

QUATERNARY DEPOSITS.

Alluvium. A glance at the areal geology map, Plate II, shows at once that the larger areas of alluvium are too valuable to utilize for farming purposes, and that towns and cities, railroads and industrial plants have been built on the level land. Probably not over one-twentieth of all the alluvium in the quadrangle is being farmed at this time. As would be expected, most of the alluvium occurs in the river-flats and along the course of the larger streams.

This alluvium consists of layers of sand, clay, and gravel on the flood plains and in the beds of the rivers. Some of the sand is loamy and well suited for agriculture. Gravel beds in the river banks are thick enough in places to warrant digging, and gravel and sand are regularly being dredged from the beds of the Allegheny and Monongahela for use in coarse aggregate in concrete. The sand, of course, is mainly quartz and fine particles of quartzite and other tough rocks. The pebbles are mostly sandstone, quartzite, quartz, and chert. Pebbles of granite and gneiss are common in the alluvium of Allegheny

River but do not occur in that of the Monongahela. The thickness of the alluvium, measured from the surface of the flood plain to bed rock in mid channel may be as much as 60 feet.

Glacial deposits. The more important glacial deposits may be separated into two groups: those of early or intermediate glacial age, which occur in terraces at an elevation above 890 feet; and those of later glacial age, which are found on the river banks and not more than 800 feet above sea level. Terraces have been noted at intermediate elevations in different parts of the quadrangle, but their bulk is small and their economic importance negligible.

The gravels of later glacial age found along Allegheny River consist of small, well-rounded pebbles and sharp, angular sand in perhaps a one-to-one proportion. There is of course a certain amount of clay and other material as well. The pebbles are of quartz, quartzite, sandstone, gneiss, granite, chert, or other material, but quartz pebbles predominate and gneissic or granitic pebbles are common. The pebbles are always hard and unweathered.

The older glacial gravels contain a greater proportion of sand and silt and the pebbles commonly exhibit some marks of weathering. Along Allegheny River pebbles of igneous rock are fairly common, but in the deposits along Monongahela and Youghiogheny Rivers such pebbles are very rare. In the latter deposits there are many white sandstone boulders from six to twelve inches in greatest diameter, but the number of small pebbles is proportionately very small. Silt and rounded grains of sand constitute the greater part of each deposit.

PERMIAN SYSTEM.

WASHINGTON GROUP.

Although 170 feet of this group is left in one hill in Union township along the southern boundary of the quadrangle, no good outcrops could be found anywhere near the top of the hill and consequently little could be learned of the detailed stratigraphy of the group at this point. The thin split coal noted at an elevation of 1180 feet on the east side of the hill and believed to be the Waynesburg, is overlain by soft shale which presumably represents the Waynesburg sandstone. Gray, fresh-water limestone (in place?) which probably was derived from the Mount Morris limestone, was noted 15 feet above the Waynesburg coal. Normally it lies 40 feet or more above that coal. Limestone boulders which presumably came from the Colvin Run limestone were noted near the top of the hill.

Several hills in Elizabeth township are also capped by the Washington group, but there also the rocks in most places are covered by a

soil layer which effectually conceals the exact nature of the strata. The Waynesburg sandstone is present in this area and is 20 to 25 feet thick.

The largest continuous area of Washington strata is in Sewickley township. A fairly good section of the lower part of the group was obtained east of Yohoghany.

Section 1 mile east of Yohoghany.

	Ft.	in.
Sandstone, white, iron-stained, coarse-grained	25	
Clay-shale, gray, iron-stained, ferruginous limy nodules at base (Mount Morris limestone horizon)	11	
Coal (upper split of Waynesburg)		6
Shale to clay-shale, greenish-yellow	7	
Sandstone, coarse-grained, fairly massive near base, with speckled appearance caused by weathering of feldspar to white clay	13	
Sandstone, shaly, soft	4	
Coal, Waynesburg		

Another section was obtained on the road going southeast from the school-house east of Shaner.

Sсstion 1 mile east-southeast of Shaner.

	Ft.	in.
Shale, soft, weathered	5	
Limestone, dark gray, impure (Mount Morris)	1	
Clay, gray	1	
Concealed	4	
Shale, greenish-yellow, soft	5	
Sandstone, cross-bedded, micaceous, iron-stained	35	
Concealed	10	
Coal (upper split of Waynesburg)		4
Clay, gray	3	
Concealed	15	
Coal, Waynesburg		

PENNSYLVANIAN SYSTEM.

MONONGAHELA GROUP.

Waynesburg coal. The Waynesburg coal, marking the top of the Monongahela formation, is usually split and too thin to be mined in the Pittsburgh quadrangle. In the section given in the preceding paragraph the combined thickness of the upper and lower splits is only 10 inches. Where measured east of Yohoghany it is unusually thick, the upper split measuring 6 inches and the lower one 24 inches. The lower split is itself split by one foot of fire-clay. The greatest thickness noted in the quadrangle was 36 inches and it occurs just west of BM 1141, southwest of Buenavista. Half a mile southwest the coal is only four inches thick.

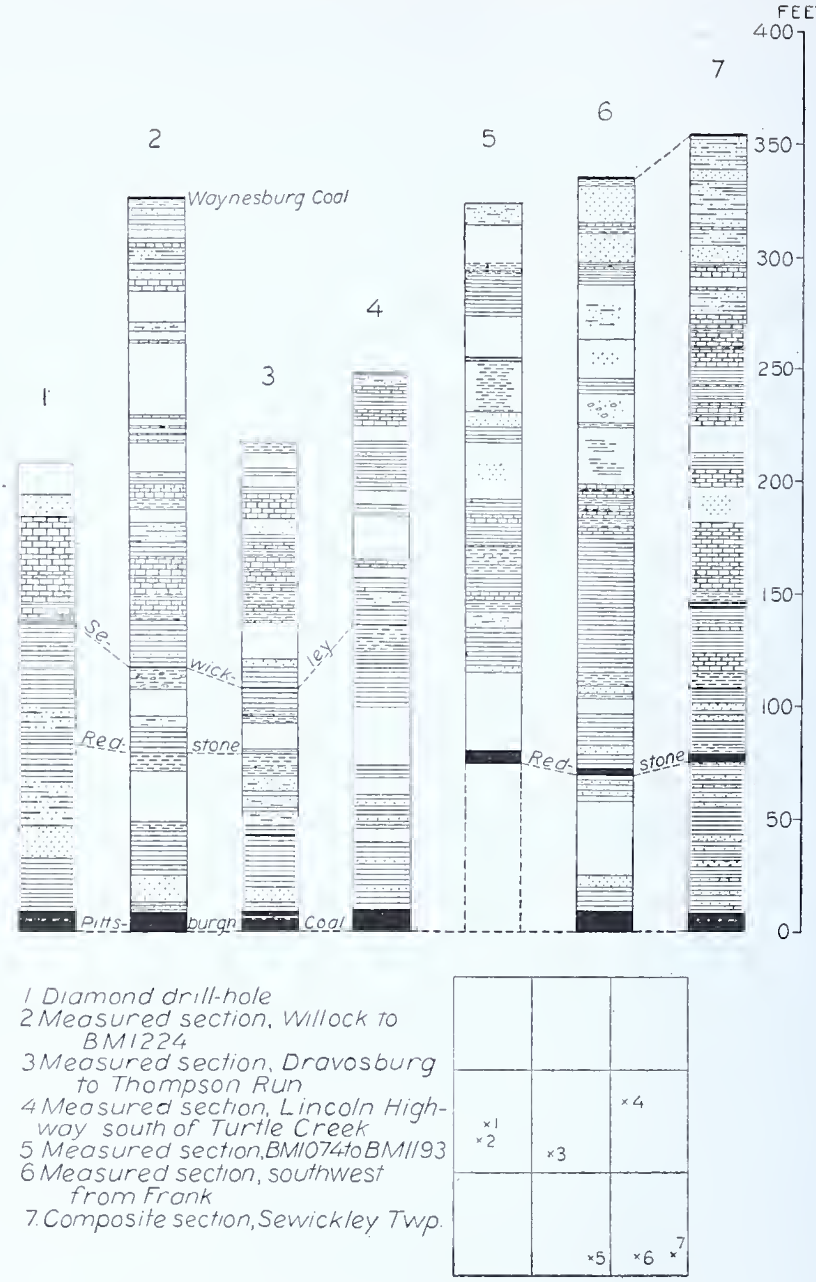


Fig. 2. Sections of the Monongahela group.

In Sewickley township the Waynesburg coal is 350 to 360 feet (See figure 2) above the base of the Pittsburgh coal. At BM 1141, southwest of Buenavista, it is 335 feet above the Pittsburgh coal. In Union township between Gastonville and Floreffe it is 335 feet above the Pittsburgh; and in Baldwin township, near BM 1224, it is 320 to 330 feet above the Pittsburgh. The tendency of the Monongahela group to thin towards the west was previously noted in the course of field work in the Greensburg quadrangle, and the thinning noted above was not therefore unexpected. The total amount of thinning from Greensburg to BM 1224 in Baldwin township is 75 feet, or at the rate of three feet per mile.

Waynesburg limestone, Uniontown sandstone and coal. The following sections illustrate the character of the upper part of the Monongahela group.

Section 1 mile east of Yohoghany.

	Ft.	in.
Coal, Waynesburg ... 4 inches to	2	
Shale and sandy shale	11	
Coal		4
Clay, gray		6
Sandstone, thin-bedded, micaceous, iron-stained	13	
Coal		2
Concealed (sandy soil)	10	
Sandstone, thin-bedded cross-bedded, greenish-yellow		8

Section 1½ miles west of Frank.

	Ft.	in.
Coal, Waynesburg	±3	
Concealed	3	
Sandstone	4	
Concealed	4	
Coal		2
Concealed	14	
Coal		1
Concealed	19	
Sandstone, yellow, fine-grained	9	
Coal, Uniontown		8
Clay, yellow		6
Concealed	13	
Sandstone, yellow, fine-grained	3	
Limestone, gray and mottled	5+	

Section at BM 1117, southwest of Frank.

	Ft.	in.
Coal, Waynesburg		4
Clay to clay-shale	5	
Sandstone	14	
Clay (partly concealed)	6	
Sandstone	12	

Section 2¼ miles west-southwest of Frank.

	Ft.	in.
Coal, Waynesburg	1	2
Shale, sandy	15	
Sandstone	5	
Shale, brown, sandy	20	
Limestone, dark grayish-blue	1	6
Shale, brown, sandy	7	
Sandstone, brown, cross-bedded	10	
Limestone, dark blue	1	

Section 100 yards southeast of BM 1224, northwest of Willock.

	Ft.	in.
Coal, Waynesburg	1	3
Clay		3
Limestone		2
Shale	13	
Sandstone, soft, thin-bedded	5	
Concealed	3	
Coal bloom, thin		±2

Section 1¼ miles west-northwest of Bruceton.

	Ft.	in.
Coal, Waynesburg	1	3
Shale with occasional thin sandstone bed	15	
Coal, Little Waynesburg		2
Clay		4
Sandstone and sandy shale	5	
Concealed	10	
Limestone, shaly		2

In a number of localities where the Waynesburg coal had been eroded the Waynesburg limestone was found fairly well developed,

particularly in Baldwin township. A maximum of 14 feet of cream-colored, shaly limestone was observed in the railroad cut 1½ miles west and a little south of Willock.

The Uniontown sandstone is neither thick nor resistant enough to weathering in this quadrangle to form the ledges and terraces by which it is characterized farther east. The Uniontown coal also is unimportant in the Pittsburgh quadrangle, never attaining a thickness of even one foot. When present it occurs below the Uniontown sandstone and above the top bed of the Benwood limestone.

Benwood limestone. The same usage is made of this name as in the Greensburg report published by this Survey; namely, it includes all limestone beds between the Uniontown coal and the Sewickley coal (or its horizon). The Benwood horizon includes many beds of shale, clay, and sandstone as well as the limestone beds. As a rule the limestone beds are seldom over 20 or 25 inches thick and they are usually separated by a few inches, sometimes feet, of clay or shale. In the upper half of the Benwood, limestone beds are comparatively few and scattered, whereas the lower half contains many beds, aggregating 35 feet or more in total thickness, and with much less interstratified clay and shale. The following sections are fairly representative of this group of beds.

Section ⅔ mile E.-NE. of Yohoghany, Sewickley township.

	Ft.	in.
Upper beds of Benwood concealed	±30	
Limestone, mottled, brown and gray	3	
Shale to sandy shale, gray to greenish-gray	6	
Limestone, argillaceous	2	
Shale, greenish-yellow, fissile	9	
Sandstone	3	
Sandstone and sandy shale, interbedded	9	
Shale, gray	14	
Limestone beds separated by thin layers of clay and shale	38	
Clay-shale, greenish-yellow	1	8
Shale, bituminous, Sewickley coal horizon	2	6

Section between Dravosburg and Thompson Run, Mifflin township.

	Ft.	in.
Top members of Benwood eroded		
Limestone boulders		
Clay	5	
Concealed	7	
Shale	3	
Concealed	5	
Shale	3	
Limestone beds, argillaceous, and concealed	11	
Sandstone	7	
Shale	3	
Limestone, gray, argillaceous	3	
Clay to clay-shale	4	
Limestone bed, mottled, gray, separated by thin layers of clay and shale	15	
Clay	6	
Limestone, gray, slightly sandy	3	
Clay-shale	4	
Limestone, brownish-gray, pimply	2	
Concealed.		

Section ½ mile west of Willock.

	Ft.	in.
Limestone (top of Benwood)	1	
Concealed	32	
Sandstone, fine-grained, thin-bedded	1	6
Concealed	3	
Sandstone	1	
Concealed	2	
Limestone, weathered white		6
Concealed	3	
Limestone	1	3
Concealed	13	
Sandstone, shaly	2	
Shale	3	
Limestone, two beds	6	
Clay	5	
Concealed	6	
Sandstone, shaly	9	
Shale, soft	6	
Limestone, hard, blue-gray, "cement rock"	1	4
Limestone with some inter-bedded clay and shale	24	11
Clay	3	
Shale, occasional thin sandstone beds	20	
Shale, carbonaceous, Sewickley coal horizon		4

Since the limestone beds of the Benwood horizon are soluble and hence more easily weathered than sandstone, in most cases it is impossible to obtain complete stratigraphic sections of this division; however, it is possible usually to determine the upper and lower limits and this was done at many points throughout the quadrangle. The interval from the base of the Pittsburgh coal to the basal limestone bed was found to vary from 125 feet to 155 feet, the average interval being about 145 feet. The interval from the base of the Pittsburgh coal to the top of the Benwood limestone ranges from 230 to 290 feet, the average interval being 265 feet.

Sewickley coal. The Sewickley coal is not of minable thickness in the Pittsburgh quadrangle but its horizon is frequently marked by a thin coal or by a bituminous shale. In the southeast corner of the quadrangle, a third of a mile north of Cowansburg, seven inches of coal occurs 147 feet above the base of the Pittsburgh coal. Three-fourths of a mile north of Clugston, Patton township, the Sewickley coal, four inches thick, outcrops on the township line road at an interval of 120 feet above the Pittsburgh coal. At the top of the river bluff on the south side of Monongahela River and near the intersection of Brownsville road and Arlington Avenue, Pittsburgh, carbonaceous shale, marking the horizon of the Sewickley coal, occurs at 142 feet above the Pittsburgh. A third of a mile northwest of BM 880 on Lobbs Run near the county line, a thin carbonaceous shale occurs at 125 feet above the Pittsburgh coal. The instances cited are typical of the Sewickley coal horizon in this quadrangle.

Fishpot limestone. The Fishpot limestone in this region is thin and irregular in its occurrence. As a sweeping generalization it may be said that it is frequently present in the southern half of the quad-

rangle and usually lacking in the northern half. Where present it occurs a few feet below the Sewickley coal horizon and averages about four feet in thickness. The following sections illustrate the character of this part of the Conemaugh group.

Section ¼ mile north of Cowansburg, Sewickley township.

	Ft.	in.
Limestone, Benwood		
Clay, ferruginous	3	
Coal, Sewickley		7
Clay-shale, gray	3	
Shale, some thin sandstone beds	5	
Shale	12	
Shale, bituminous	1	
Clay, limestone nodules	2	
Limestone, gray, Fishpot	2	
Clay-shale	1	
Sandstone, hard, gray, calcareous	3	
Shale, gray	11	
Clay, yellow, limestone concretions	3	6
Shale, sandy, and thin sandstone beds	4	
Shale, drab	4	
Sandstone, hard, gray, flaggy, Sewickley	16	
Concealed	4	
Sandstone, hard, gray, calcareous, Sewickley	3	
Shale and concealed	10	

Section on west side of Youghiogheny River at south boundary of quadrangle.

	Ft.	in.
Limestone and interbedded clay, Benwood,	12	
Clay	3	2
Coal, top 4 inches bony, Sewickley	1	1
Shale, gray, fissile	14	
Shale, bituminous		8
Clay, large limestone nodules, Fishpot, in upper 2 feet	12	
Clay-shale	2	6
Shale	8	
Clay-shale	4	
Shale and thin sandstone beds, interstratified	7	
Shale	6	6
Coal, Redstone	3	10½
Clay		

Section in Lobbs Run west of BM 880 near county line.

	Ft.	in.
Limestone, Benwood		
Concealed	5	
Sandstone, gray, micaceous	5	
Shale		
Limestone, weathered white Fishpot	3	6
Shale,	30+	

Section exposed in bluff across river (north) from downtown McKeesport.

	Ft.	in.
Limestone, Benwood		
Clay	7	
Concealed (probably clay and soft shale)	12	
Sandstone	3	
Shale	7	
Shale, carbonaceous, Sewickley coal horizon	1	
Clay	16	
Shale, soft, light brown	22	
Sandstone, compact, massive, Sewickley	4	
Shale, soft, brown	8	6
Sandstone, massive, Sewickley	2	10
Clay, Redstone		

Section 3 miles west of Clugston, Patton township.

	Ft.	in.
Limestone, Benwood		
Clay	6	
Sandstone, shaly, thin-bedded	9	
Shale	12	
Concealed	5	
Shale	3	
Sandstone, shaly, Sewickley	7	
Shale, light yellow	9	
Concealed	16	
Sandstone, thin-bedded, containing considerable interbedded shale, Sewickley	17	
Clay, Redstone		

Sewickley sandstone. The sections just given also illustrate the usual character of the Sewickley sandstone. Ordinarily the more massive beds occur close above the Redstone coal horizon and their total thickness does not usually exceed 25 feet. In places the sandstone is almost entirely lacking, its place being taken by shale. A maximum of 40 feet of thin-bedded, micaceous, shaly sandstone occurs in Portvue township between Otto and Portvue.

Redstone coal, clay, and limestone. The areal extent of the Redstone coal where thick enough to be mined, is shown in Plate XV. A constant element in the stratigraphy of the southern part of the quadrangle, the coal thins towards the north, and in much of the northern half of the quadrangle its horizon is marked only by an inch or two of carbonaceous shale—sometimes not even that. The interval from the base of the Pittsburgh coal to the base of the Redstone, ranges from 59 to 90 feet, averaging 73 feet. The interval changes greatly in comparatively short distances; for example, in the valley of Hayden Run, Forward, and Elizabeth townships, it decreases from 85 feet to 67 feet in two-thirds of a mile. But the increase or decrease of the interval in any one direction is not constant, the interval being just as great in the vicinity of Bruceton as it is near Cowansburg or northeast of Duquesne, and the same at Hays as it is near Buenavista. In spite of this variation in interval, the horizon, including the clay (and sometimes a limestone bed) beneath the coal, is constant enough to form a good stratigraphic marker for the separation of Sewickley sandstone and Pittsburgh sandstone.

The clay beneath the Redstone coal is more persistent than the coal itself and is usually from 5 to 10 feet thick. The Redstone limestone, on the other hand, is comparatively rare in this quadrangle, and is nowhere more than two feet thick. The maximum thickness, two feet, occurs about one mile west of Camden, Mifflin township.

Pittsburgh sandstone. The Pittsburgh sandstone is a most variable stratum. Hard, massive, and 35 feet thick at Fairhaven, it is almost lacking one mile north. A mile farther north it is represented by 30 feet of interbedded sandstone and shale; and three miles north

of Fairhaven, along the river bluff, it is 60 feet thick (including a small amount of interbedded shale). This thickness rapidly disappears towards the east and north and in the city of Pittsburgh, between the two rivers, the Pittsburgh sandstone horizon is predominantly shaly. The sandstone has no distinguishing characteristics by which it can be recognized, its identification depending upon its relations to the strata above and below.

Pittsburgh rider coal. This thin coal bed, appearing only occasionally at an interval of 15 to 50 feet above the base of the Pittsburgh coal, is not thick enough to be mined anywhere in the quadrangle. A maximum thickness of 14 inches was observed 26 feet above the base of the Pittsburgh coal in the valley of the north fork of Lobbs Run about 1⅛ miles east of B.M. 1004. About a fifth of a mile north of Fairhaven station one foot of coal was observed at 27 feet above the base of the Pittsburgh coal. These two thicknesses are unusual as nowhere else was the coal found to exceed 6 inches. The following typical section of the basal beds of the Monongahela group was measured in the ravine at the north end of the McKeesport-Duquesne bridge.

Section near north end of Duquesne-McKeesport bridge.

	Ft.	in.
Shale		
Coal, Pittsburgh "rider"		3
Shale	1	
Sandstone	5	
Shale	2	
Coal, Pittsburgh		

Pittsburgh coal. The basal member of the Monongahela group is the Pittsburgh coal and its widespread occurrence and uniformity of character and section are well known. Mined in the vicinity of Pittsburgh as far back as 1760, there are still many thousands of tons of this valuable coal in this quadrangle in the form of mine pillars and barriers, as well as a small amount of virgin coal. The wonderful regularity of the main bed is partly brought out in figure 17. In every part of the quadrangle the roof coal is present and from two to four feet thick. The draw slate, in reality a fairly pure fireclay, is always present and usually about 11 inches thick. The main bed of coal is 5½ to 6 feet thick. Even the thin partings above and below the "bearing in" coal can always be found if the coal is well exposed. Because of its easy recognition and widespread outcrop the Pittsburgh coal forms an excellent stratigraphic marker and is so used in mapping the geology and structure of the rocks throughout this region.

CONEMAUGH GROUP.

Pittsburgh should properly be the type locality of the Conemaugh, for there are more well-exposed stratigraphic sections of that group near Pittsburgh than there are in any other part of western Pennsylvania. Within the limits of the Pittsburgh quadrangle there are a great number of places where the rocks above the Buffalo sandstone are well exposed and where detailed measurements can be made. All such exposed sections were measured in the course of field work for this report and all of the longer sections are included herein.

The Conemaugh group is exposed in outcrop along all of the rivers and larger streams and also along the axis and flanks of the major anticlines. The character of this group is shown in Figures 4 to 14. A glance at these illustrations indicates immediately why the name "Barren Measures" was originally applied to the Conemaugh; for, from the standpoint of those looking for workable coal beds, the Conemaugh is certainly barren in this region. In the Pittsburgh quadrangle there is no coal of mineable thickness between the base of the Pittsburgh and the top of the Upper Freeport coal, the top and bottom limits respectively of the Conemaugh.

The fairly rapid thinning of the Conemaugh group from east to west is brought out in Figure 3. This figure also shows that most of the thinning takes place in the lower part of the group. The thinning from Rillton in Sewickley township, Westmoreland County, to Lock No. 3 on Monongahela River, is at the rate of five feet per mile.

Pittsburgh limestone. As many as eight different beds of limestone have been noted within 70 feet below the base of the Pittsburgh coal. In some places only one or two limestone beds occur in that interval. Most of the beds are irregular and local in their occurrence and because of that fact it has been deemed wisest to classify them all under the name Pittsburgh limestone, rather than attempt to attach individual names to each. The beds in this 70 foot interval are so thin and diversified that it was not possible to show the character of this part of the Conemaugh in the illustrations. For that reason a few typical sections are given in detail.

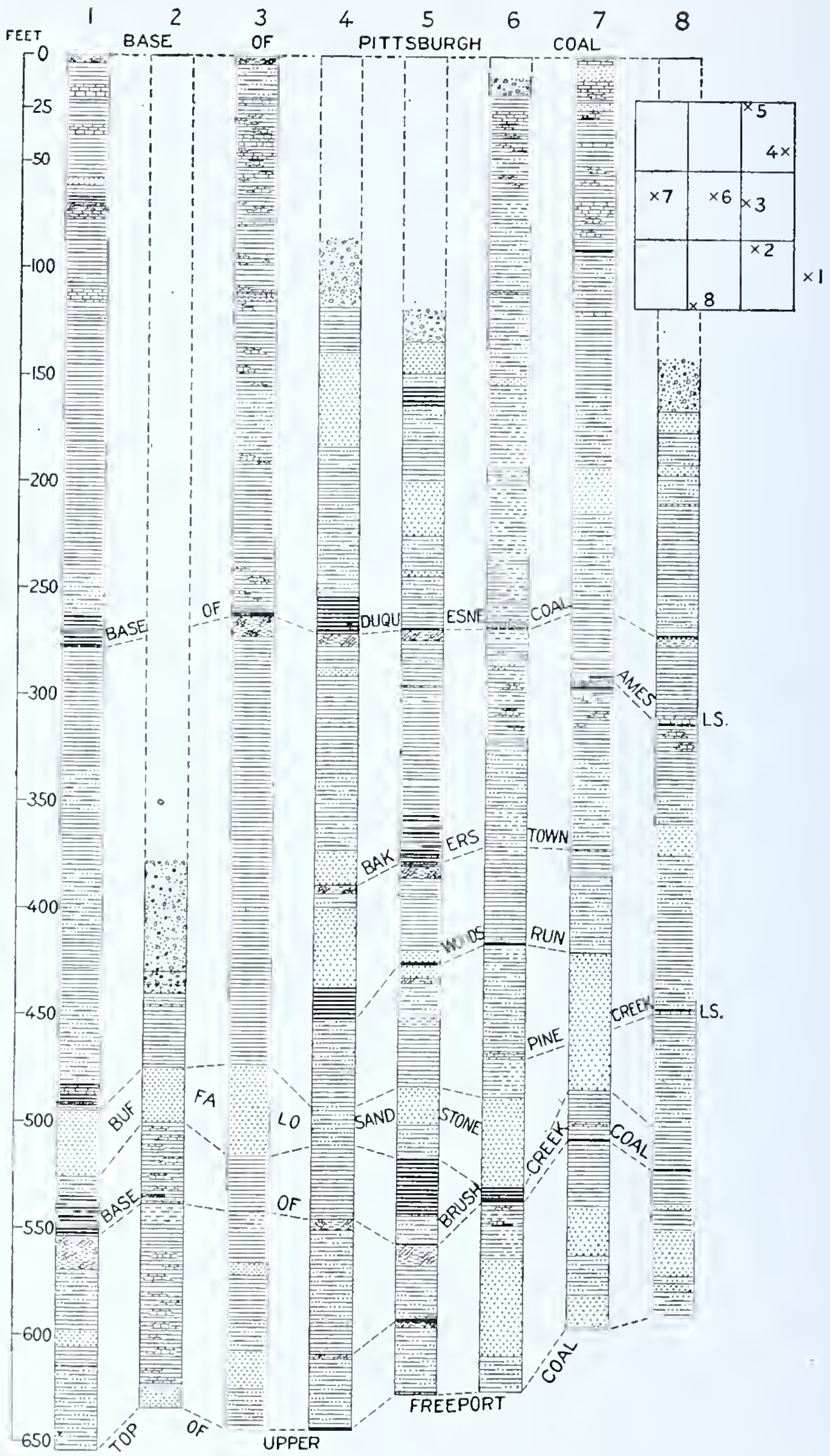


Figure 3. Diamond drill-hole sections in the Conemaugh group.

1. Rillton, Sewickley township.
2. Near Youghiogheny River between Boston and Greenock.
3. One-fourth mile north of B. M. 1174 near East McKeesport.
4. Clugston, Patton township.
5. One-fifth of a mile north of B. M. 1194, between Sandy Creek and North Bessemer.
6. One-fourth mile north-northwest of B. M. 1081, south of Terrace, Mifflin township.
7. Two miles west of Hays.
8. One-fourth mile south of Lock No. 3, Monongahela River.

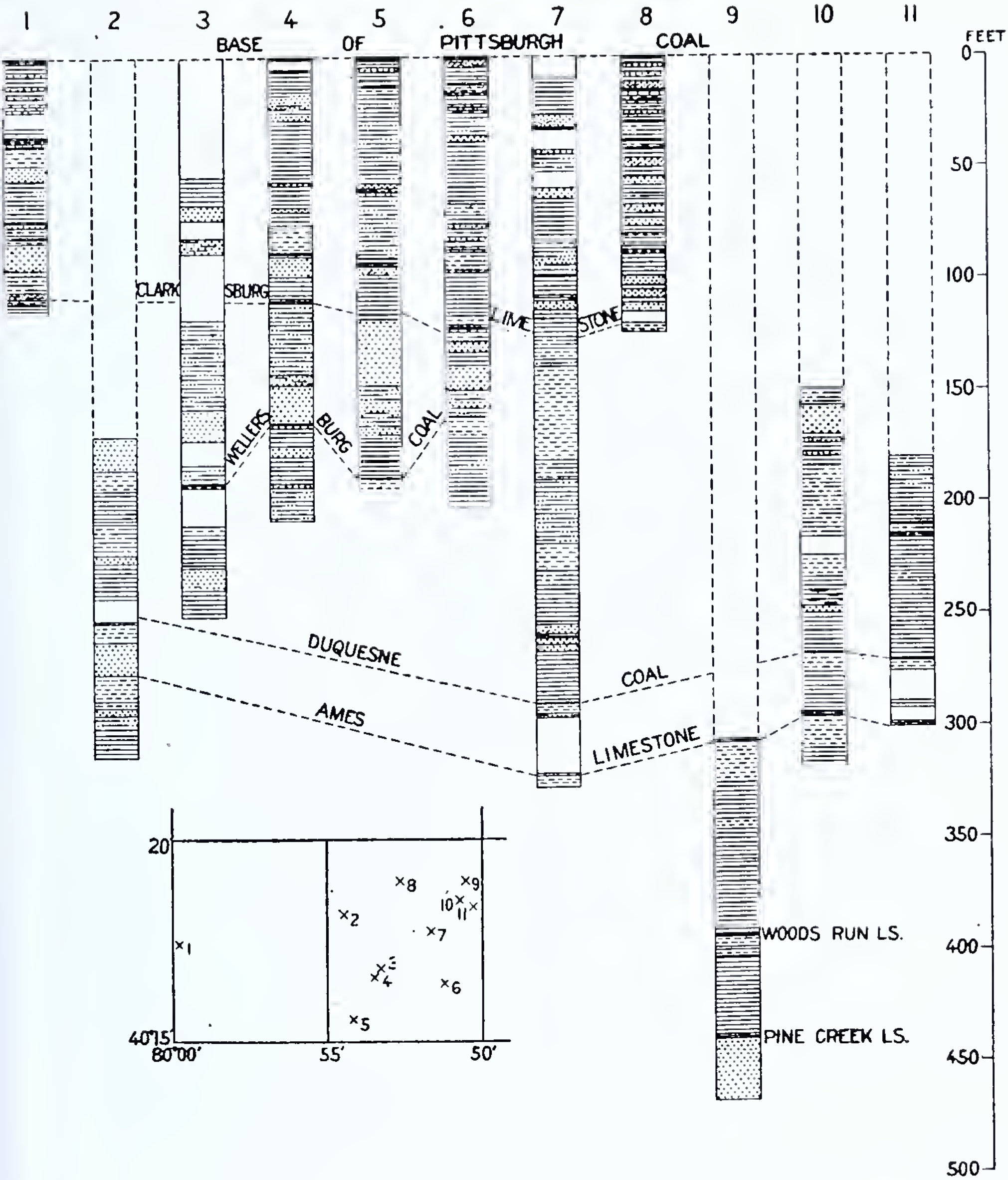


Figure 4. Sections of the Conemaugh group in the south-central part of the quadrangle.

1. Upper part of the Conemaugh group near B. M. 928, west-northwest of Snowden.
2. Middle part of the Conemaugh group near the mouth of Peters Creek.
3. Upper part of the Conemaugh group ½ mile north of West Elizabeth.
4. Upper part of the Conemaugh group at West Elizabeth.
5. Upper part of the Conemaugh group along Monongahela River south of Elizabeth.
6. Upper part of the Conemaugh group, Wiley Run to B. M. 1074.
7. Upper half of the Conemaugh group half a mile south of Belle Bridge, Lincoln Township.
8. Upper part of the Conemaugh group 1⅓ mile northwest of Belle Bridge.
9. Lower part of the Conemaugh group at the quarry of the Union Sewer Pipe Company, Versailles.
10. Middle part of the Conemaugh group ¾ mile west of Boston.
11. Middle part of the Conemaugh group, Pigeon Hollow, ¾ of mile southwest of Boston.

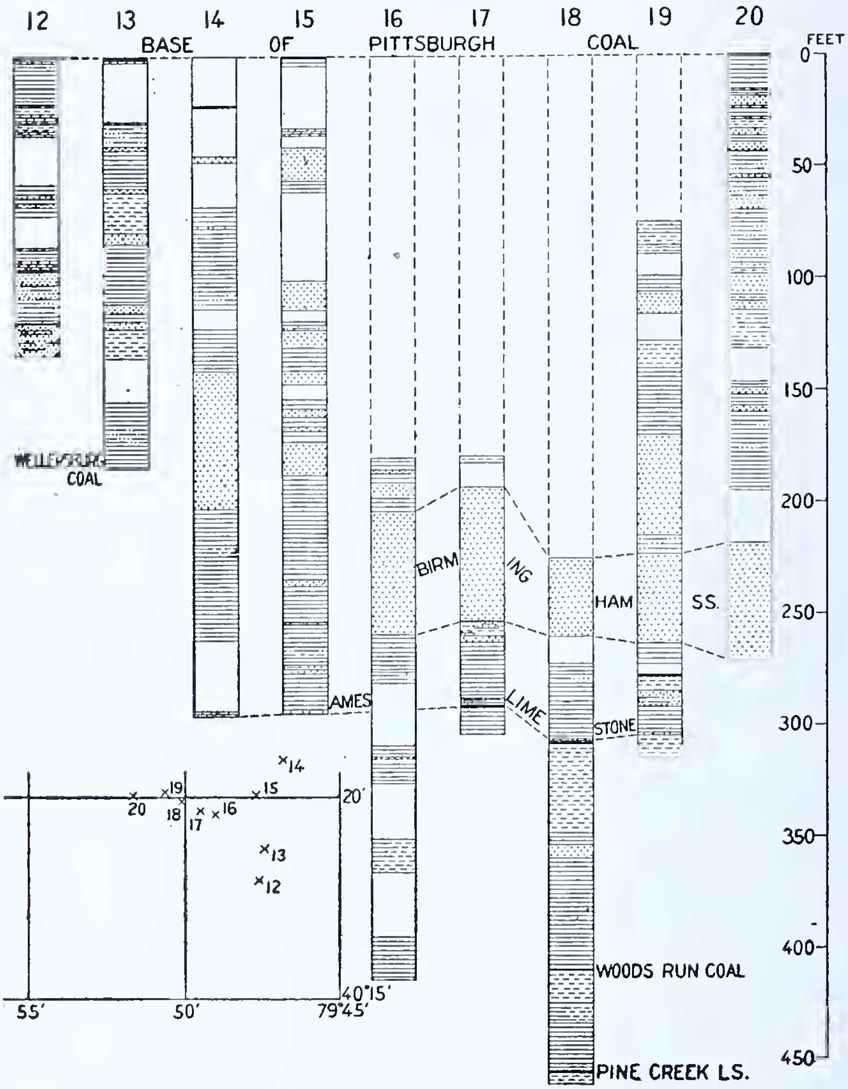


Figure 5. Sections of the Conemaugh group between Robbins Station and McKeesport.

12. Upper part of the Conemaugh group midway between Robbins Station and Coulter.
13. Upper part of the Conemaugh group ½ mile southwest of Emblem, North Huntingdon township.
14. Upper half of the Conemaugh group 2½ miles north of Emblem, North Huntingdon township.
15. Upper half of the Conemaugh group 1½ miles north of Greenock, Elizabeth township.
16. Middle part of the Conemaugh group 1 mile northeast of Boston.
17. Middle part of the Conemaugh group 1 mile north-northeast of the Boston-Versailles bridge.
18. Middle part of the Conemaugh group 1¼ miles north-northwest of the Boston-Versailles bridge.
19. Middle part of the Conemaugh group, Patterson Avenue, Christy Park, McKeesport.
20. Upper part of the Conemaugh group at Portvue.

Section near B. M. 1036, Wiley Run, Elizabeth Twp.

	Ft.	in.
Pittsburgh coal		
Concealed	1	6
Sandstone	1	6
Shale	3	
Limestone, smooth-fractured, gray	2	
Shale	2	
Limestone, rough-fractured, gray	1	6
Shale	2	
Clay, gray	2	
Limestone, light gray	1	3
Clay, ferruginous	3	
Limestone, gray	1	
Clay, gray	2	
Shale	15	
Sandstone	4	
Shale	3	
Clay, greenish-gray, weathers to a deep red	2	
Shale	15+	

Section ½ mile south and a little west of the junction of Youghiogheny and Monongahela Rivers.

	Ft.	in.
Pittsburgh coal		
Shale, thin sandy lenses		10
Shale, carbonaceous		10
Limestone		0–7
Clay, gray to greenish	5	
Coal, shaly		4
Limestone, impure, dark gray	1	
Clay containing limestone nodules	3	
Shale	3	
Sandstone		3
Shale	1	
Clay	1	
Limestone		8
Clay	1	
Limestone	1	3
Clay	1	6
Shale, sandy	7	
Clay	5	
Sandstone.		

Section at Guffey station on the B. & O. Railroad.

	Ft.	in.
Pittsburgh coal		
Fireclay		6
Limestone	1	6
Shale, sandy	9	
Shale, bituminous		2–4
Limestone, impure, many spirorbis noted		6–10
Sandstone and some interbedded gray shale	8	
Shale	4	
Coal and bituminous shale, Little Pittsburgh		3–8
Limestone, carbonaceous, no fossils		8
Shale, bituminous		2
Limestone, carbonaceous		3
Clay	5	8
Limestone, massive	4	6
Clay-shale	11	
Sandstone.		

Section one mile north of Fairhaven.

	Ft.	in.
Pittsburgh coal		
Clay, containing limestone nodules	1	
Limestone		3
Shale, sandy, and sandstone	5	
Limestone	3	6
Clay and nodular limestone	2	
Shale	7	
Limestone	2	3
Clay.		

Section ¼ mile northeast of B. M. 999, east of Wilkinsburg.

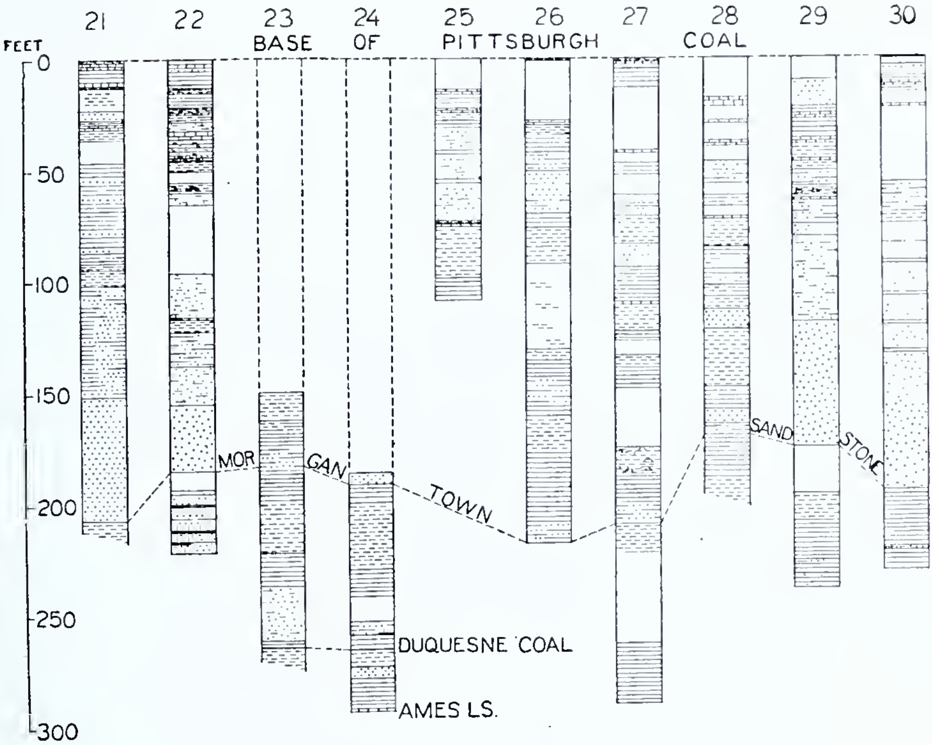
	Ft.	in.
Pittsburgh coal		
Fireclay	1	
Shale, sandy		5
Limestone	1	3
Clay		5
Sandstone, shaly	9	
Shale, carbonaceous		6
Limestone, massive (3 beds)	4	1
Clay		2
Shale, carbonaceous		3
Clay		3
Shale, bituminous		4
Limestone		8
Clay	1	
Limestone, nodular	1	6
Clay, limestone nodules	3	
Shale, sandstone	7	
Limestone	1	4
Clay		3
Limestone		8
Clay, limestone nodules	2+	

The thickest and the most persistent of the Pittsburgh limestones occurs from 25 to 40 feet below the base of the Pittsburgh coal. It attains its maximum development in the southern third of the quadrangle.

Little Pittsburgh coal. The name Little Pittsburgh has been used to designate thin and unimportant coal beds which occur as lenses of small areal extent from 9 to 52 feet below the base of the Pittsburgh coal. Such lenses occur commonly in the southern part of the quadrangle and at an interval of 20 to 30 feet below the Pittsburgh. A maximum of 18 inches of coal, 50 feet below the Pittsburgh, was observed in Peters Creek valley about 1¼ miles southeast of Cochrans Mill.

Connellsville sandstone. The Connellsville sandstone is the first important sandstone below the base of the Pittsburgh coal. The top of the sandstone is from 60 to 100 feet below the coal and its thickness ranges from a few feet to 55 feet. Like other sandstones in this region it is composed of fine to medium-sized quartz grains with some arkosic material and some muscovite. Individual beds are seldom as much as three feet thick and usually "pinch out" quickly in all directions. Shale is frequently interbedded with the sandstone. The unweathered sandstone is light gray in color, but as ordinarily seen in outcrop it is yellowish, sometimes with a greenish tinge. The sandstone attains a maximum development near the mouth of Turtle Creek and is very thick also near the mouth of Peters Creek and in Wilkins township where Duffs Run and Chalfant Run unite.

Little Clarksburg coal. In this quadrangle the horizon of the Little Clarksburg coal, occurring 100 to 135 feet below the base of the Pittsburgh coal, is occasionally marked by a thin carbonaceous shale or bony coal. More frequently there is no trace of coal between the Connellsville and Morgantown sandstones. The following section, showing the maximum observed thickness of Little Clarksburg, was



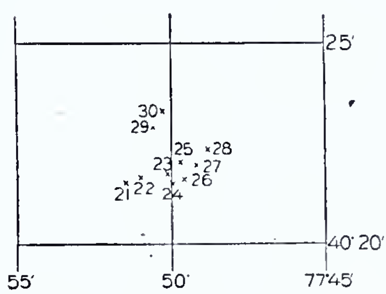


Figure 6. Sections of the Conemaugh group near Duquesne.

21. Upper part of the Conemaugh group half a mile west of the north end of the Duquesne-McKeesport bridge.
22. Upper part of the Conemaugh group at the north end of the Duquesne-McKeesport bridge.
23. Middle part of the Conemaugh group at Demmler Station, near McKeesport.
24. Middle part of the Conemaugh group in the north end of McKeesport.
25. Upper part of the Conemaugh group at B. M. 1057, about ¼ mile southwest of East McKeesport.
26. Upper part of the Conmaugh group at Fite Station, Crooked Run to B. M. 1057.
27. Upper part of the Conemaugh group, Crooked Run, 1 mile south-southwest of East McKeesport.
28. Upper part of the Conemaugh half a mile south of East McKeesport.
29. Upper part of the Conemaugh group 1 mile southeast of Port Perry, North Versailles township.
30. Upper part of the Conemaugh group half a mile east of Port Perry, North Versailles township.

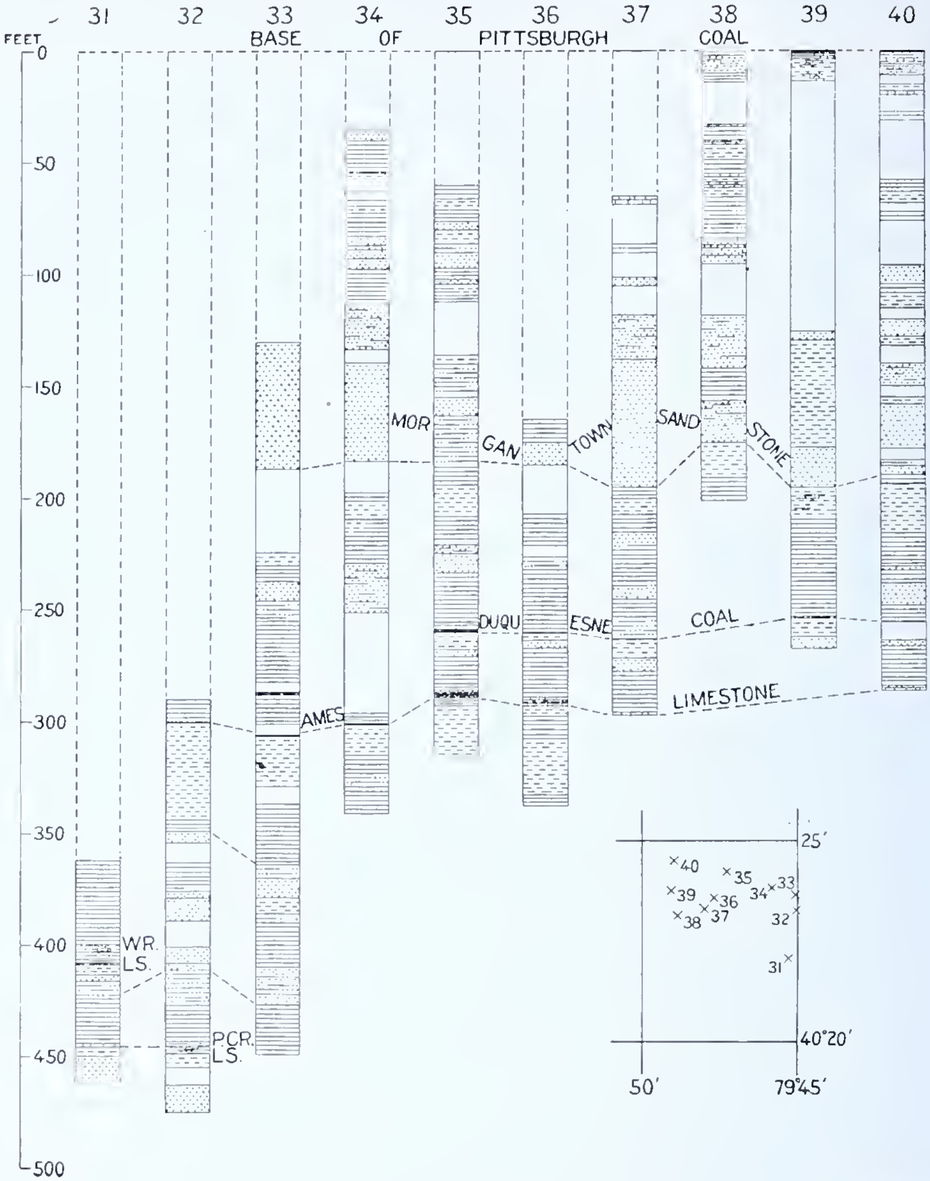


Figure 7. Sections of the Conemaugh group near Trafford City and Wilmerding.

31. Lower part of the Conemaugh group at the big cut of the Pennsylvania Railroad, 1¼ miles southeast of Trafford City.
32. Lower part of the Conemaugh group at Trafford City.
33. Middle part of the Conemaugh group 1½ miles north-northeast of Trafford City.
34. Upper part of the Conemaugh group 1 mile north of Trafford City station.
35. Upper part of the Conemaugh group, hill west of Pitcairn.
36. Middle part of the Conemaugh group, 1 mile east of Wilmerding.
37. Upper part of the Conemaugh group, east side of East McKeesport to Wilmerding.
38. Upper part of the Conemaugh group west side of East McKeesport to Wilmerding.
39. Upper half of the Conemaugh group south of the Pennsylvania Railroad, tracks between East Pittsburgh and Wilmerding.
40. Upper half of the Conemaugh group at Turtle Creek borough.

measured at the John H. Ward & Son's quarry near the north boundary of Wilkinsburg and about one mile west-northwest of B. M. 995.

Section showing the Little Clarksburg coal at the John H. Ward & Son's quarry, Wilkinsburg.

	Ft.	in.
Interval from top of section to base of Pittsburgh coal	130	
Clay, ferruginous		4
Coal, bony, and bituminous shale	1	5
Clay		3
Shale, carbonaceous		4
Clay	1	6
Limestone	1	
Clay	1	
Limestone	2	
Clay.		

Across the valley from Cochrans Mill a very thin coal was noted at 110 feet below the base of the Pittsburgh coal.

Section of Little Clarksburg coal near Cochrans Mill.

	Inches
Shale	
Limestone, carbonaceous	1
Coal	1
Shale, carbonaceous	11
Clay	

Another good exposure of this horizon occurs in the valley of Whittaker Run, Mifflin township, one mile northeast of B. M. 1155. At this point the coal is 123 feet below the Pittsburgh.

Section in valley of Whittaker Run.

	Ft.	in.
Shale	5+	
Shale, carbonaceous	1	
Coal, very bony		4
Clay		

Clarksburg limestone and clay. This soft horizon, easily weathered and frequently concealed by soil or vegetation, is extremely variable in its character and was often noted only as a weathered red clay occurring between the Connellsville and Morgantown sandstones. The greatest thickness of the limestone occurs near Coulter in the south tip of Versailles township. The following section was noted in the river bluff above the railroad tracks about half-way between Coulter and Robbins Station.

Section of Clarksburg limestone southeast of Coulter.

	Ft.	in.
Cancealed		
Limestone		10
Shale and thin sandstone beds	5	
Limestone, massive	4	
Shale, sandy	1	
Sandstone, Morgantown		

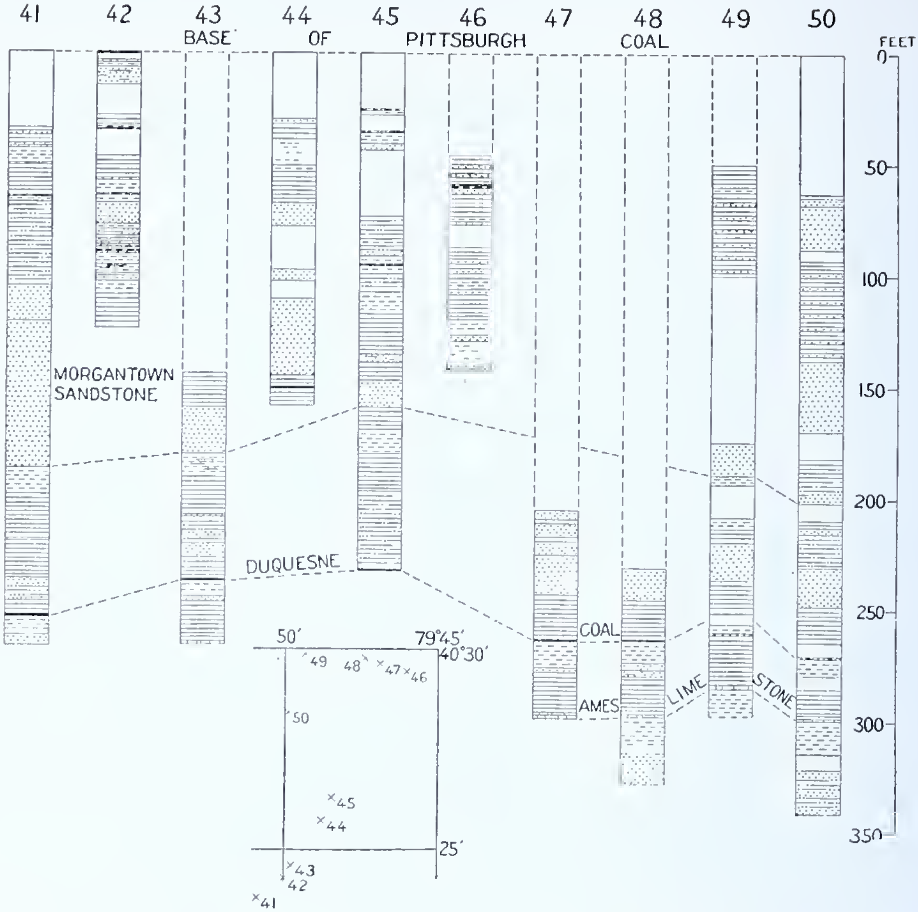


Figure 8. Sections of the Conemaugh group between North Braddock, New Texas, and Sandy Creek.

41. Upper part of the Conemaugh group at the Keller & Milliken Brick Works, half a mile north-northeast of the mouth of Turtle Creek.
42. Upper part of the Conemaugh group ⅓ mile west of the bend in the Pennsylvania Railroad at Turtle Creek borough.
43. Middle part of the Conemaugh group near Turtle Creek borough.
44. Upper part of the Conemaugh group half a mile north of Linhart.
45. Upper half of the Conemaugh group in the southeast corner of Penn township.
46. Upper part of the Conemaugh group between Unity Station and New Texas.
47. Middle part of the Conemaugh group at Unity Station.
48. Middle part of the Conemaugh group at North Bessemer.
49. Upper half of the Conemaugh group southeast of Verona.
50. Upper half of the Conemaugh group from ¼ to 1¾ miles east of Sandy Creek.

Across the river from Coulter the rapidly changing appearance of this horizon may be observed, the massive limestone bed noted in the section given above thinning rapidly from its greatest thickness here, three feet, until it is entirely replaced by strikingly cross-bedded sandstone. Another good exposure of the Clarksburg limestone occurs in the valley south of Boston and leading to the Wiley Run road. Here also there are two beds of limestone and at a point about one mile south of B. M. 780 they measure 30 inches (upper bed) and 36 inches (lower bed). This is the maximum observed thickness of the Clarks-

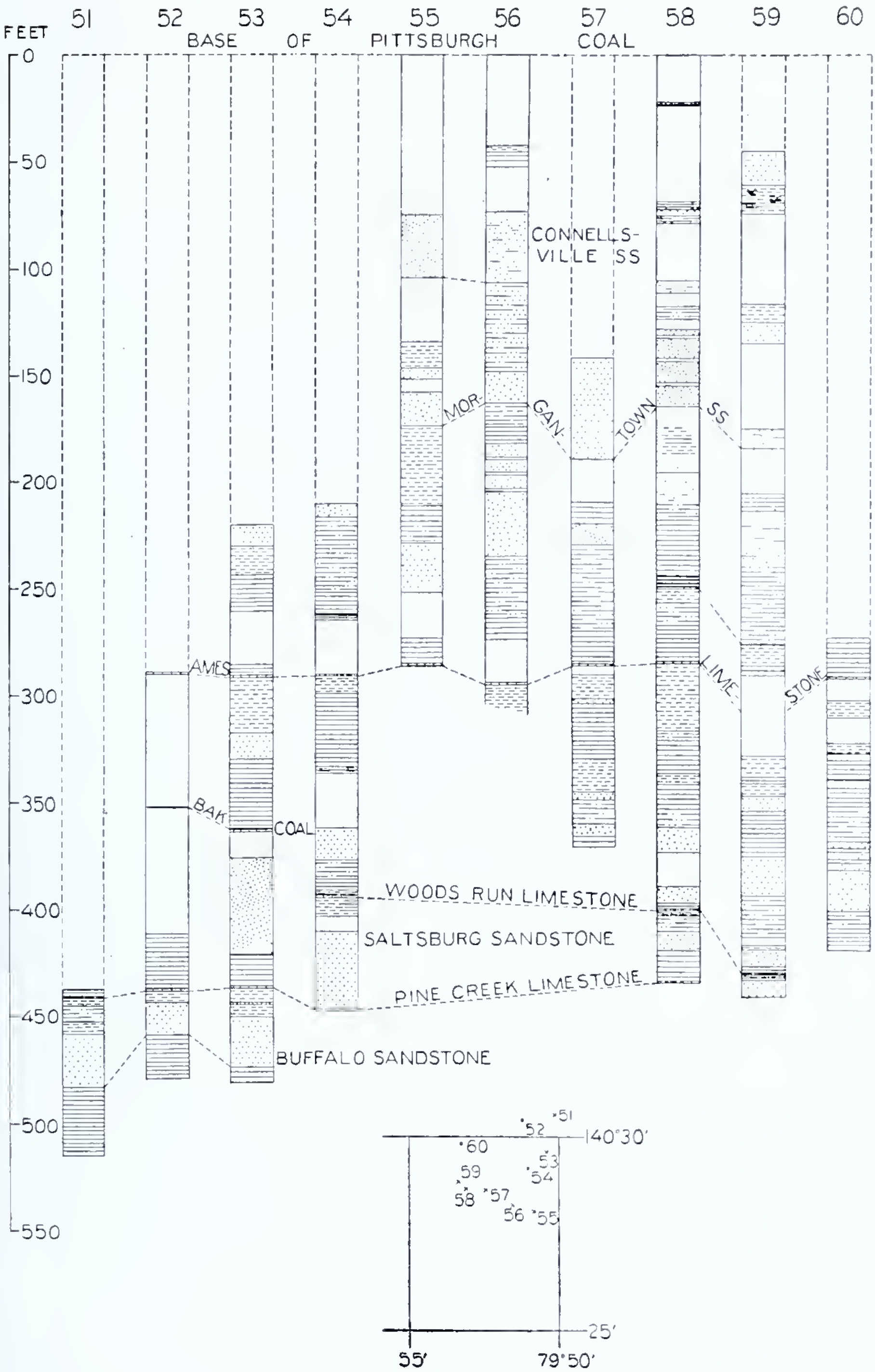


Figure 9. Sections of the Conemaugh group near Nadine and Sandy Creek Station.

51. Lower part of the Conemaugh group at Verona, Penn township.
52. Lower part of the Conemaugh group at Glenover, on the west bank of Allegheny River half a mile north of the north boundary of the quadrangle.
53. Lower part of the Conemaugh group 1 mile northeast of Sandy Creek station.
54. Middle part of the Conemaugh group near Sandy Creek.
55. Upper part of the Conemaugh group, Sandy Creek south to top of hill.
56. Upper part of the Conemaugh group, Sandy Creek toward the southwest.
57. Middle part of the Conemaugh group half a mile south-southeast of Nadine.
58. Section from the Pittsburgh coal to the Pine Creek limestone measured betwen Nadine and the end of the Lincoln car line 1 mile southwest.
59. Section of the Conemaugh group 1 mile east of the south end of the Aspinwall bridge.
60. Lower part of the Conemaugh group 1 to 1½ miles northeast of the Aspinwall bridge.

burg limestone. In other parts of the quadrangle the limestone seldom attains a thickness of more than one foot and is frequently entirely lacking from the section.

The Clarksburg limestone and associated clay beds occur from 90 to 135 feet below the base of the Pittsburgh coal, the average interval to the limestone being about 105 feet.

Morgantown sandstone. The Morgantown sandstone is the most valuable and the most conspicuous of all the sandstones occurring within the quadrangle. Typically a cross-bedded, medium to fine-grained sandstone with some interbedded shale, in places the lower beds become very massive, the basal bed opposite McKeesport and near the north end of the Duquesne bridge measuring 29 feet. In many other places the basal bed is from 10 to 20 feet thick. Occasionally a conglomerate occurs at the base of the Morgantown, this being the only horizon at which conglomerate was found anywhere in the quadrangle. Good exposures of the conglomerate are to be found on the north side of the Frankstown road just east of Dornbush Street in Wilkinsburg; at the foot of the bluff on Chestnut Street above Spring Garden Street, North Side, Pittsburgh; a few feet above the Duquesne boulevard at a point half a mile southeast of the Rankin bridge; in an abandoned quarry on the north slope of the valley of Long Run, Versailles township, about one mile east of the mouth of that stream; and half a mile northeast of B. M. 881 on Lincoln Way road, Versailles township. Except where it is massive, the Morgantown is similar to other sandstones in color and general appearance. The sandstone usually has a very uneven base, suggestive of a short period of erosion previous to its deposition. It varies rapidly in thickness, an extreme example of this characteristic occurring near the mouth of Turtle Creek where a maximum of 75 feet of sandstone exposed in the Keller & Milliken quarry half a mile north-northeast of the stream mouth, is almost entirely replaced by clay and shale 1½ miles towards the east. The sections, Figures 4 to 13, illustrate this characteristic rather well.

Usually the Morgantown sandstone is separated from the Connellsville by the clay and limestone of the Clarksburg group. Sometimes however the two sandstones merge, as in the deep valley north of Rankin and east of Swissvale, and also half a mile southwest of Camden. Similarly the Morgantown as a rule is separated from the Birmingham sandstone and shale by the Wellersburg clay and limestone, but occasionally, as at the quarry in the north slope of Long Run valley, these two sandstones also merge.

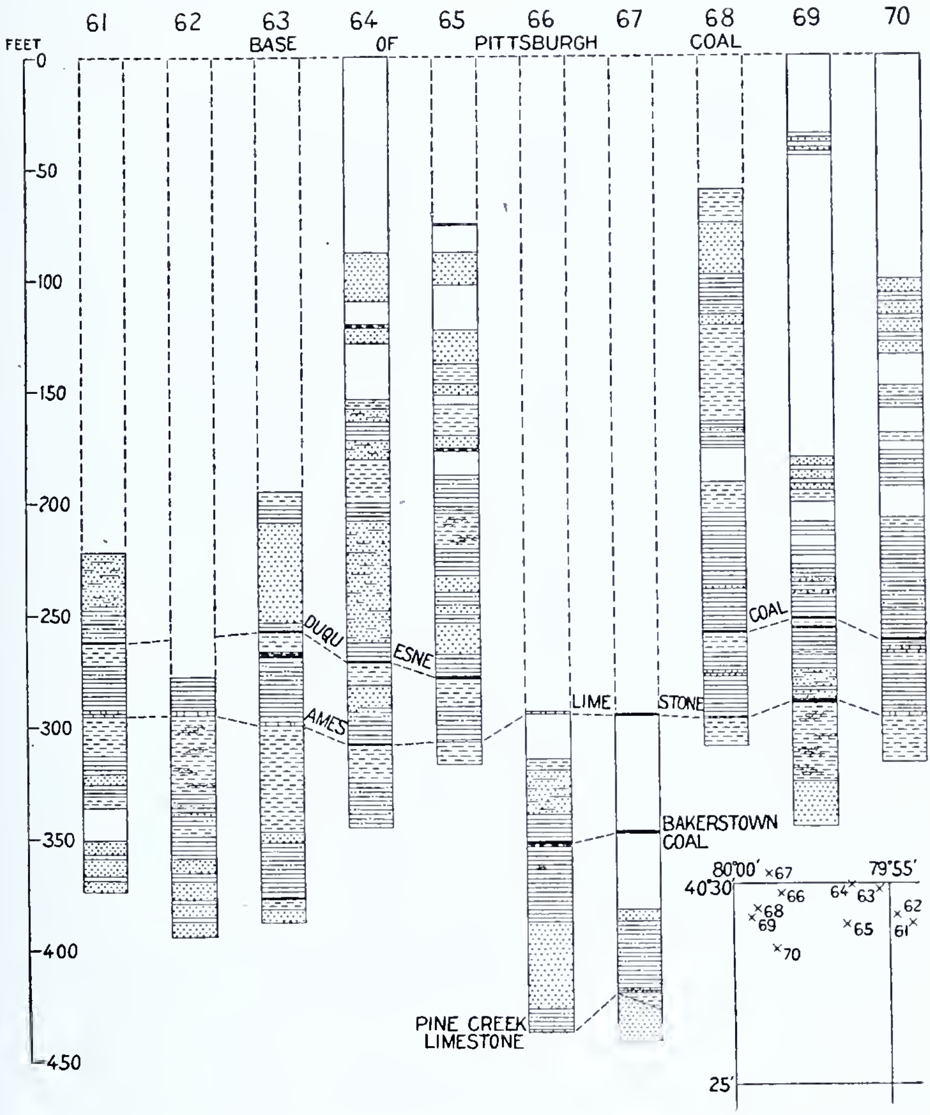


Figure 10. Sections of the Conemaugh group near Aspinwall, Etna, and Millvale.

61. Middle part of the Conemaugh group at the south end of the Aspinwall bridge.

62. Middle part of the Conemaugh group ¼ to ¾ mile west of the south end of the Aspinwall bridge.

63. Middle part of the Conemaugh group ¼ mile northwest of Sharpsburg station.

64. Upper part of the Conemaugh group ½ mile north of the Etna bridge.

65. Section of the Conemaugh group ⅓ mile southwest of the south end of the Etna bridge.

66. Lower part of the Conemaugh group ⅓ mile southeast of B. M. 804, north of Millvale.

67. Lower part of the Conemaugh group on Girty Run (flows south through Millvale), ¼ mile north of the quadrangle boundary.

68. Upper half of the Conemaugh group ⅓ mile southeast of B. M. 1193, Reserve township.

69. Upper part of the Conemaugh group ¾ mile west-northwest of Millvale.

70. Upper part of the Conemaugh group ½ mile north of the middle of Herrs Island.

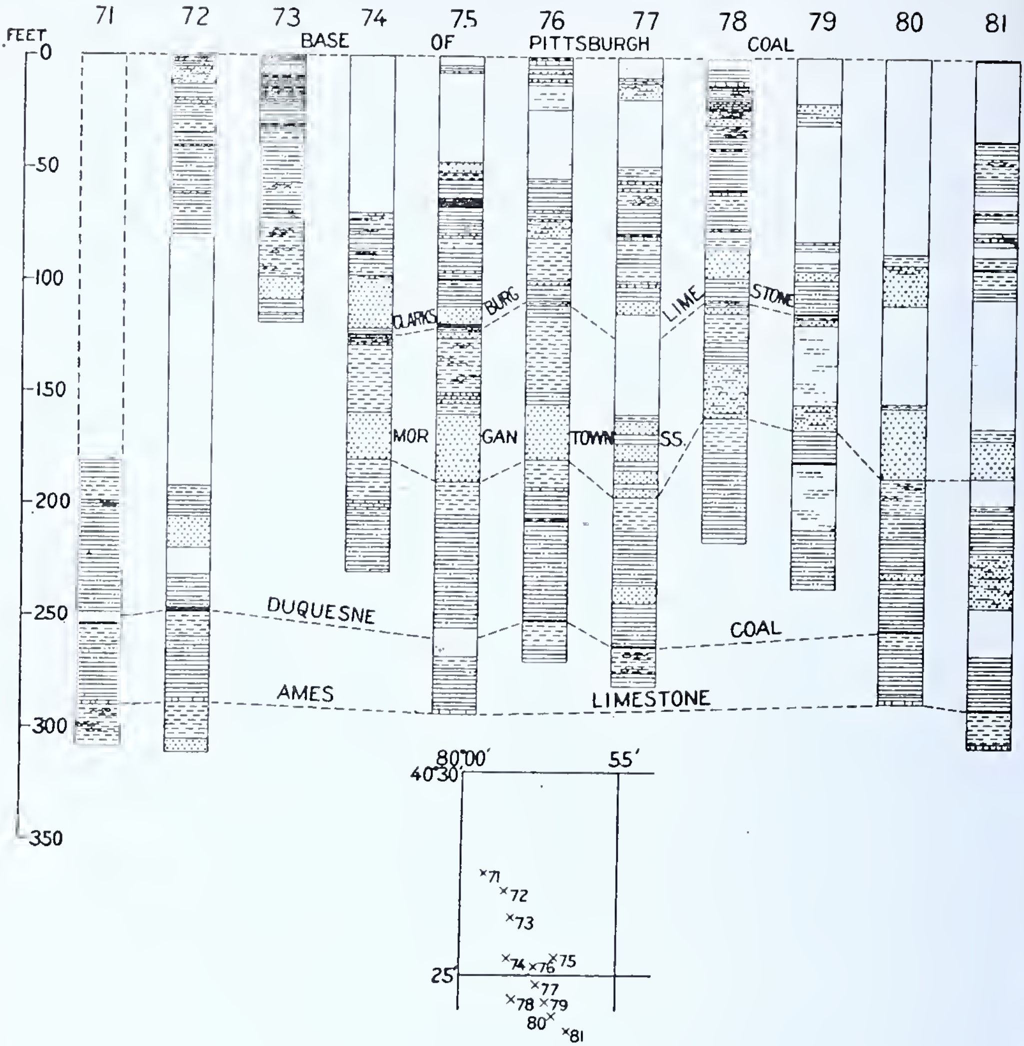


Figure 11. Sections of the Conemaugh group from Troy Hill, in the North Side district of Pittsburgh, to Hays Station.

71. Middle part of the Conemaugh group ¼ mile southwest of the lower end of Herrs Island.
72. Upper half of the Conemaugh group 1 mile south of the center of Herrs Island.
73. Upper part of the Conemaugh group ⅓ mile north of Brady Street bridge (1¼ miles west of Schenley Park).
74. Upper part of the Conemaugh group at Sankey Brothers' quarry, ½ mile south of the 10th Street bridge, Pittsburgh.
75. Upper half of the Conemaugh group at the mouth of the two small streams which bound Schenley Park on the west and south.
76. Upper part of the Conemaugh group at the M. Lanz Brick Plant, ⅔ mile north-northeast of the mouth of Becks Run.
77. Upper half of the Conemaugh group at the mouth of Becks Run.
78. Upper part of the Conemaugh group in the valley of Becks Run.
79. Upper part of the Conemaugh group 1½ miles northwest of Hays Station.
80. Upper part of the Conemaugh group 1 mile northwest of Hays Station.
81. Upper half of the Conemaugh group ¼ mile west of Hays Station.

The interval from the base of the Pittsburgh coal to the base of the Morgantown sandstone was measured in a great number of places and was found to vary from 170 to 210 feet. The usual interval is from 185 to 200 feet.

Wellersburg coal, clay, and limestone. In this quadrangle the Wellersburg coal is too thin to be of any value except as a "key" rock in geologic work. A maximum of 14 inches of coal was observed a quarter of a mile north of West Elizabeth in the steep bluff facing the river. At this point the coal occurs as a small lens in the Morgantown sandstone just above its base, the section being as follows:

Section ¼ mile north of West Elizabeth.

	Ft.	in.
Shale, brown	3	
Concealed	5	
Shale	5	
Sandstone, massive, cross-bedded, Morgantown	40	
Coal, Wellersburg	0 to 1	2
Sandstone	1	6
Shale	1	
Concealed.		

On the opposite side of the river the coal was noticed at the foot of the river bluff south of Elizabeth; near the mouth of Hayden Run; and about a mile east of the mouth of Wiley Run. It was also found in the river bluff below the abandoned Osceola Mine across the river from Greenock; in a bank beside the Pigeon Hollow road, two-thirds of a mile southwest of Boston; and in two or three places near Turtle Creek and Linhart. In none of these places is the coal more than 4½ inches thick.

Occurring usually near the base of the Morgantown sandstone, the interval from the Wellersburg coal to the base of the Pittsburgh coal is about the same as from the base of the sandstone; namely, 180 to 215 feet.

The Wellersburg clay is a much more persistent stratum than the coal and is usually found, from 5 to 15 feet thick, in its position below the Morgantown horizon and above the Birmingham. The clay is similar in appearance to others occurring in the quadrangle. When unweathered it is an olive gray or drab color, but weathering oxidizes the pyrite contained in it and causes it to turn dull red.

The Wellersburg limestone, like the coal, is seldom seen. Where it does occur it is impure and usually nodular, and is found in the middle or towards the base of the Wellersburg clay.

Birmingham shale and sandstone. The Birmingham shale and sandstone lie between the Wellersburg clay and the Duquesne coal. This horizon is well exposed in a great many places throughout the quadrangle and its variable composition may be closely studied. In its type locality, the Birmingham or South Side district, Pittsburgh, the upper 10 or 12 feet is usually a soft red shale. The red color of this horizon and of the Wellersburg clay just above are very conspicuous across the river and particularly in the deep gorges on the west and south sides of Schenley Park. Hence the name Schenley

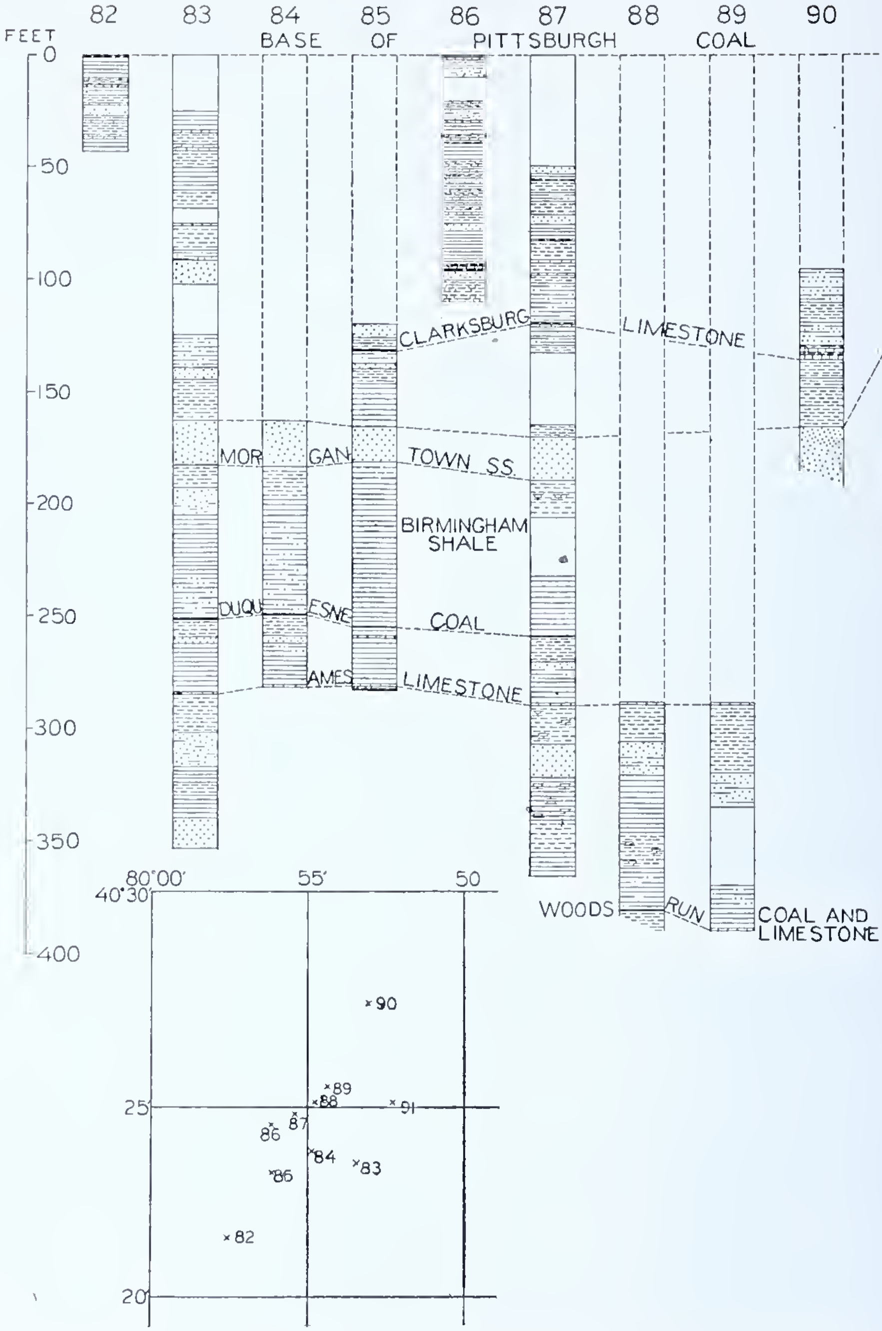


Figure 12. Sections of the Conemaugh group near Homestead.

82. Upper part of the Conemaugh group ½ mile northeast of Willock.

83. Upper half of the Conemaugh group along Whitaker Run between Terrace and Homestead.

84. Middle part of the Conemaugh group at the quarry of the J. B. Coen Brick and Tile Works, west end of Homestead.

85. Middle part of the Conemaugh group ⅓ mile southeast of Hays Station.

86. Upper part of the Conemaugh group 1 mile north of the north end of Hays bridge.

87. Upper half of the Conemaugh group exposed along Murray Ave., west from the Homestead bridge.

88. Lower part of the Conemaugh group at the mouth of Ninemile Run, Pittsburgh.

89. Lower part of the Conemaugh group ¾ mile northeast of the mouth of Ninemile Run.

90. Upper part of the Conemaugh group at the quarry of John H. Ward and Sons Company, ½ mile northeast of the bend in the Pennsylvania Railroad between Wilkinsburg and Homewood.

91. Upper part of the Conemaugh group 1 mile northeast of the Rankin bridge.

red beds has sometimes been applied to them. The Pennsylvania Survey however has not adopted this usage for the excellent reasons that in very many places these beds are not red and because the name overlaps that of the Wellersburg horizon.

A good section of the Birmingham shale in its type locality may be viewed at the Sankey Brothers' quarry near the foot of Eighteenth Street, and about $1\frac{1}{4}$ miles east of the western boundary of the quadrangle. The section there is as follows:

Section at Sankey Brothers' quarry.

	Feet
Nodular limestone (Wellersburg) and clay	4
Clay, Wellersburg	3
Shale, brown to dull red	10
Sandy shale and shaly sandstone	30

A complete section may be seen three-quarters of a mile farther east at the M. Lanz quarry.

Section at the M. Lanz quarry.

		Ft.	in.
Clay, Wellersburg		11	
Nodular limestone, Wellersburg		1	8
Shale, fissile, red	Birmingham	11	
Clay-shale	Birmingham	1	4
Shale, drab, sandy	Birmingham	40	
Shale, carbonaceous, Duquesne coal horizon.			

At the mouth of Becks Run a change is noticeable.

Section at mouth of Becks Run.

	Feet
Clay, Wellersburg	14
Shale, soft	11
Shale, sandy	15
Sandstone	8
Shale, sandy at top, fissile towards bottom	17
Shale, carbonaceous, Duquesne coal horizon.	

At Walton's coal tipple (abandoned) about one mile to the south, the section is much the same except that the sandstone is there only three feet thick. At Hays, Homestead, and Kennywood Park the section is similar. But at Duquesne massive sandstone beds begin to appear and at McKeesport these have become very prominent. At Portvue the shale is almost completely replaced by sandstone, and two miles to the east-southeast the replacement is complete. Almost this same condition exists in the bluff behind Sharpsburg, the section there being as follows:

Section at Sharpsburg.

	Feet
Clay, Wellersburg	
Shale, soft, yellow	8
Sandstone	45
Shale, sandy	3
Shale, carbonaceous, Duquesne coal horizon.	

Near Unity Station and Pitcairn there is also a greater thickness of sandstone than of shale; but at Belle Bridge shale again predominates.

If a line be drawn on a map of the Pittsburgh quadrangle separating it into two parts, one part representing the area in which sandstone predominates in the Birmingham horizon, and the other part representing the area in which shale predominates, that line will pass west of Etna, through Wilkinsburg, east of Turtle Creek and East McKeesport, through Duquesne, Dravosburg and Camden, and between Belle Bridge and Boston. If a second line be drawn through the points at which conglomerate was noticed, it will be found that this second line has the same general trend as the first line—namely, northwest and southeast. To the writer the evidence seems conclusive that at the time the middle Conemaugh sediments were laid down, the shore-line of the great northern Appalachian basin followed this same trend in this locality. Furthermore, if we assume, as would seem likely, that the shore-line of the Mississippian and late Devonian seas was roughly parallel to that of the middle Pennsylvanian, then this geologic problem assumes economic importance; for to the man in search of oil or gas it is highly desirable to know the direction in which the oil and gas sands may be expected to thin and disappear.

The total thickness of the Birmingham horizon ranges from 45 to 70 feet, the average being 50 to 55.

The presence of marine fossils in the Birmingham shale has been noted by Raymond[17] and others. Stratigraphically this is the highest member in which such fossils have been found in western Pennsylvania. Evidently the disturbance which caused the widespread deposition of the sand which in its consolidated state we now call the Morgantown sandstone, and which caused faulting on a minor scale in the shale and sandstone beds of the Birmingham horizon, also caused a change in the northern Appalachian basin from marine to fresh-water conditions.

Duquesne coal, clay and limestone. The name Duquesne having been finally adopted for the coal bed occurring just below the Birmingham shale, the writer was considerably amused to find that at the foot of Patterson Avenue in the central part of Duquesne where this horizon is well exposed, the coal is entirely lacking, drab Birmingham shale resting directly on the Duquesne clay. Nevertheless the name is not considered inappropriate, for the coal does occur on all sides of Duquesne and is conspicuously exposed at many places within a radius of two miles of that city. Although the coal thins and thickens in a most irregular fashion, either the coal, or a

[17]Raymond, P. E., A preliminary list of the fauna of the Allegheny and Conemaugh series: Annals of the Carnegie Museum, Vol. VII, No. 1, p. 149, 1910.

carbonaceous shale representing it was noted at more than 80 different places scattered throughout the northern half and southeastern quarter of the quadrangle. The changing character of the Duquesne coal is well exposed along the main line of the Pennsylvania Railroad between Union Station, Pittsburgh, and the point about $2\frac{1}{2}$ miles east where the Pennsylvania tracks cross over the Baltimore & Ohio Railroad tracks. At the station the coal is represented by 5 inches of carbonaceous shale. About one mile to the northeast we find 6 inches of coal. A quarter of a mile farther the coal has disappeared, only to reappear 7 inches thick within another quarter of a mile. At the sharp bend to the south about 3 miles from the station, the coal horizon is occupied by 12 inches of gray shale. Equally good exposures of the Duquesne coal, or its horizon, may be seen on both sides of Monongahela River as far south as Duquesne; in the bluffs facing Allegheny River; and on both sides of Turtle Creek as far east as Pitcairn.

The coal is 10 to 12 inches thick near Turtle Creek and Linhart. At Sandy Creek it is again 12 inches thick; and at Unity Station it is 8 inches thick. The area within the triangle formed by these places contains the maximum development of the Duquesne coal.

The interval from the base of the Pittsburgh coal to the Duquesne coal ranges from 252 to 275 feet, and averages 265 feet.

The Duquesne clay is even more persistent than the coal and is found almost everywhere the horizon outcrops, an exception being the west end of the high hills in Pittsburgh where this part of the Conemaugh is unusually irregular (see Figure 14). The general appearance of the clay is similar to others in this district, it being unstratified and drab or olive-gray in color. Limestone nodules are frequently present in the lower part of the bed. The average thickness of the clay is 9 feet; the maximum observed thickness, 16 feet.

The Duquesne limestone is a thin fresh-water limestone which occasionally appears directly below or within a few feet of the base of the Duquesne coal. It is most conspicuous in that part of the bluff on the north side of Allegheny River which faces Herrs Island, the limestone attaining its greatest thickness, $3\frac{1}{2}$ feet, at a point directly opposite the north end of the island. A hundred yards from the mouth of Becks Run large blocks of Duquesne limestone, 8 to 12 inches thick and containing great quantities of ostracod shells, were noted. A third interesting occurrence is along the Peters Creek branch of the Pennsylvania Railroad, about 600 yards southwest of B. M. 740 on the bridge over Peters Creek. At this point the Grafton sandstone is unusually thick and the strata above the limestone are concealed, hence the correlation of the limestone, here 15 inches thick,

was in some doubt until the section near B. M. 740 (see section 2, fig. 4) was studied.

Grafton sandstone. In this quadrangle the Grafton sandstone is seldom over 5 feet thick and in only one restricted locality, namely, the mouth of Peters Creek, is it over 8 feet thick. It is well exposed along Fifth Avenue near Lincoln Way in McKeesport and on both sides of Turtle Creek from the borough of that name to the Monongahela. Frequently the sandstone is represented only by sandy shale; sometimes there is no trace of it. Where present it is similar in appearance to other sandstones already described.

The interval between the Grafton sandstone and the Ames limestone is occupied by shale, the upper half of which is frequently red.

Ames limestone. This marine limestone is the highest, stratigraphically, of all the marine limestones occurring in western Pennsylvania. Because of its position almost in the middle of the Conemaugh, its widespread occurrence and easy recognition, it is a most valuable aid to the geologist and from that standpoint ranks next in importance to the Pittsburgh coal in the vicinity of Pittsburgh. In

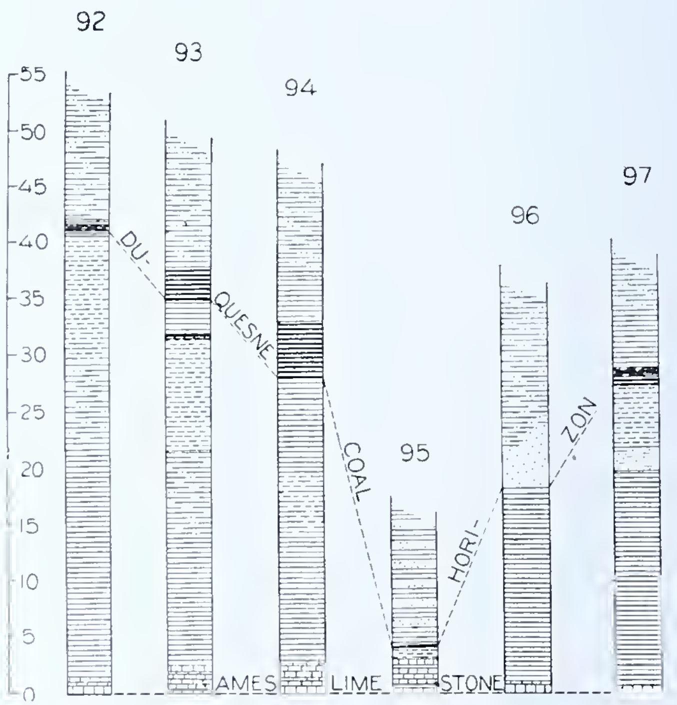


Figure 13. Sections of the middle part of the Conemaugh group near the junction of Allegheny and Monongahela Rivers.

92. One mile northeast of Union Station, Pennsylvania Railroad.
93. One hundred yards east of Union Station, Pennsylvania Railroad.
94. West end of hill near Baltimore & Ohio Railroad station.
95. Opposite the mouth of Allegheny River.
96. North end of 10th Street bridge over Monongahela River.
97. One-third of a mile east of the north end of the Brady Street bridge.

Plate XI

A. Ames limestone half a mile east of Wilmerding.

B. Ames limestone half a mile east of the south end of the Duquesne-McKeesport bridge.

C. Ames limestone and Harlem coal at Millvale.

its typical occurrence it is a greenish-gray or greenish-yellow limestone from 6 inches to 4 feet thick. Where it is 2 to 4 feet thick it usually occurs as two or three closely spaced beds separated one from another by a few inches of limy shale. It is always marked by an abundance of fossils, chief among which are crinoid stems, *chonetes granulifer* (a small brachiopod) and *Ambocoelia planoconvexa* (a small, marine bivalve with a prominent beak). Occasionally it is shaly and soft, as in places between Troy Hill, southwest of Herrs Island, and Millvale; ordinarily it is more resistant to weathering than the adjacent soft shale and clay, and stands out prominently except where covered by vegetation. It was found everywhere the horizon outcrops except on one side of the little knoll at B. M. 740, mouth of Peters Creek (n. b. the knoll is not shown on the topographic map), at which point it was eroded previous to the deposition of the Grafton sandstone.

Strictly speaking, the Ames limestone and the Pittsburgh coal are not parallel horizons. For that reason before one can draw a structure map involving the use of both beds, it is necessary to know the interval between the two at as many points as possible. A list of such intervals at the localities specified is here given:

Interval from base of Pittsburgh coal to base of Ames limestone.

Locality	Feet
Reserve township	292
Sharpsburg	295
Sandy Creek	285
Unity Station	295
1 mile west of Universal	301
Center, Plum township	306
1 mile north-northwest of Clugston	311
$1\frac{1}{4}$ mile north and a little east of Clugston	322
1 mile northwest of Clugston	305
$\frac{2}{3}$ mile north-northwest of Clugston	311
1 mile southwest of Unity Station	305
Pitcairn	300
2 miles south of Trafford City	295
Between East Pittsburgh and East McKeesport (determined from diamond drill-holes),	295
Turtle Creek (field determination)	270
Linhart (field determination)	265
Wilmerding (field determination)	285
Boston	308
Greenock	309
Lock No. 3, Monongahela River	312
Belle Bridge	305
Terrace, Mifflin township	300
Homestead	290
Hays	280
Hays Station	290
2 miles west of Hays	293
1 mile south-southwest of the mouth of Becks Run	287
Monongahela River at west boundary of quadrangle	283

The discrepancy between the intervals near Turtle Creek is probably due in part to the use of the barometer in determining elevations; in part to shortening of the interval north of East Pittsburgh;

and in part to incorrect estimation by the drillers of the depths to the various beds encountered.

Harlem coal. The Harlem coal is thin and valueless in this quadrangle. It was noted in its usual position close beneath the Ames limestone in a number of places, but in no place is it more than 12 inches thick and even that thickness is very local. It is well exposed in the river bluff southwest and northeast of Millvale and along the road between Wilmerding and Pitcairn.

Pittsburgh red beds. This name, or as more commonly stated, the Pittsburgh red shale, is given to the red beds beneath the Ames and above the Saltsburg sandstone. In this quadrangle it applies only to the thick bed of clay occurring at that horizon. The name is somewhat unfortunate inasmuch as the color of the clay is frequently drab or olive-gray. The clay is well exposed along the railroad tracks leading into Pittsburgh, and in general wherever the Ames limestone outcrops. The thickness of the clay is quite variable, ranging from a few feet to 47 feet, depending upon the unconformity at its base. This unconformity is quite marked in places, as in the steep hills back of Sharpsburg, along the main line of the Pennsylvania Railroad near Union Station, south of Brilliant along the Pennsylvania Railroad tracks, and along the Baltimore & Ohio Railroad tracks between Hazelwood and Ninemile Run. Evidently a period of erosion of indeterminate length occurred previous to the deposition of the clay.

In Maryland and West Virginia a fresh-water limestone often occurs in the Pittsburgh red beds from 10 to 30 feet below the base of the Ames. This limestone, the Ewing, was seen at only one place in this quadrangle; namely, on the road between Wilmerding and Pitcairn, where it occurs 26 feet below the Ames and ranges from 0 to 8 inches thick.

Bakerstown coal. This is the Upper Bakerstown of regions where two coal beds occur in the interval between the Harlem coal and the Pine Creek limestone. North of Allegheny River the Bakerstown coal is frequently seen 55 to 72 feet below the base of the Ames limestone. It thins rapidly towards the south however and one small area between the mouth of Ninemile Run and a point 1¼ miles west-northwest of Hays represents the only occurrence of this coal south of Allegheny River and east of longitude 79° 50′ W. In the area just mentioned it is seen in outcrop along the Baltimore & Ohio Railroad tracks about a third of a mile west of the mouth of Ninemile Run, and in a short distance ranges from 0 to 15 inches thick.

The interval from the Ames to the Bakerstown coal increases both to the south and to the east. In the vicinity of B. M. 804, Shaler township, the interval is 55 to 60 feet. At Etna it is 60 feet, and half

a mile southeast of Verona it is 72 feet. Near Clugston diamond drill-holes went through the coal at intervals of 72 to 96 feet. A diamond drill-hole about one mile west of Hays Station found the coal at 74 feet below the Ames.

Eleven inches of dark gray, carbonaceous limestone, containing ostracods and spirorbis (small fresh-water fossils) occurs directly below the Bakerstown coal at the outcrop half a mile southeast of Verona. This is the only known outcrop of this limestone in the Pittsburgh quadrangle, although it was noted also in a drill-hole two miles west of Hays.

Saltsburg sandstone. In this quadrangle the Saltsburg sandstone is divided into two or three parts. The upper part of the sandstone occurs between the Ames limestone and the Bakerstown coal. Frequently it is seen as a shaly sandstone just below the Pittsburgh red beds. Occasionally it is 15 to 20 feet thick, as in Shaler township and near Homestead. More often it is thin or even entirely replaced by shales and clay, as in the quarry of the Union Sewer Pipe Company, opposite Versailles. In general, this part of the sandstone is thickest in the northern part of the quadrangle. It is the equivalent of the Jane Lew sandstone of the West Virginia Geological Survey.

Between the Bakerstown coal and the Woods Run horizon we find another sandy stratum, usually only a few feet thick but occasionally becoming quite massive, as in the ravine one mile northeast of Sandy Creek Station where it is continuous with the lower Saltsburg sandstone beds and the Woods Run horizon is lacking. At that point the sandstone is 45 feet thick and resembles both the Birmingham and Morgantown sandstones in districts where they are massive; the texture of the Saltsburg however, is somewhat coarser than that of the others.

The sandstone beds between the Woods Run coal and limestone and the Pine Creek limestone are more persistent than the upper beds and in the north half of the quadrangle several quarries have been operated in this part of the Saltsburg. Generally speaking, this horizon is not so much cross-bedded as the sandstones occurring in the upper half of the Conemaugh. This horizon is well exposed on the south side of Allegheny River between Nadine and Verona, and along Evergreen Road from B. M. 804, Shaler township, towards the northwest. Near Trafford City and Versailles this horizon is also well exposed, but in that region the lower part of the Saltsburg is largely composed of shale.

Woods Run limestone and coal. The Woods Run limestone is an impure, fossiliferous limestone occurring in one or two thin beds

from 80 to 119 feet below the Ames and from 35 to 55 feet above the Pine Creek limestone. A thin coal, never more than 6 inches thick, frequently occurs just below the upper bed or at the horizon of the upper bed in places where that bed is missing. Many types of fossils were found in the Woods Run limestone and although at present no index fossils can be listed to identify this horizon, it can be said that in general there is a much greater proportion of gastropods than in either the Ames or Pine Creek limestones.

The Woods Run horizon is well exposed at Nadine, where the upper limestone bed, 5 to 6 inches thick, is 102 feet below the Ames and 17.4 feet above the lower limestone bed which is 2 to 4 inches thick. The Woods Run coal does not occur in this vicinity. Recently a cut made near the junction of the old Squaw Run brick road and the new concrete road which follows up the valley, exposed two inches of ferruginous, argillaceous, Woods Run limestone at an elevation of 787 feet. The Ames outcrops farther up the brick road at an elevation of 884; the interval between the two therefore is 97 feet. Neither the coal nor the limestone beds occur in the northwest part of the quadrangle. At the mouth of Ninemile Run, 2 inches of Woods Run coal occurs about 83 feet below the Ames. Following up the stream the coal disappears but in its place one finds 0 to 3 inches of typical Woods Run limestone. Here the interval to the Ames appears to be about 90 feet. A third of a mile south of the station at Trafford City the Woods Run horizon is well exposed along the Pennsylvania Railroad tracks, the section being as follows:

Section a third of a mile south of Trafford City

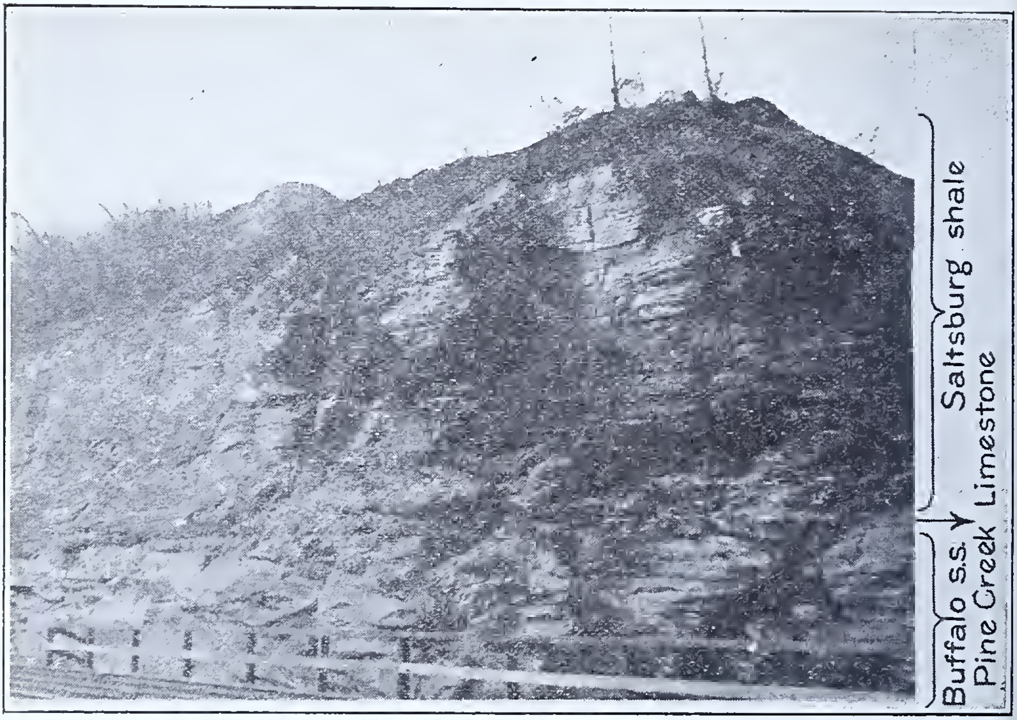
	Ft.	in.
Shale, gray towards base, greenish-yellow above	40	
Lime, fossiliferous, Woods Run		2
Clay, many limestone nodules	3	
Shale, yellow or reddish	5	
Limestone, fossiliferous (?) Woods Run		1½
Clay, greenish-yellow	5	
Sandstone, Saltsburg.		

A very complete section of the Conemaugh from the Ames limestone to the Buffalo sandstone is exposed in the quarry of the Union Sewer Pipe Company, across the river from Versailles.

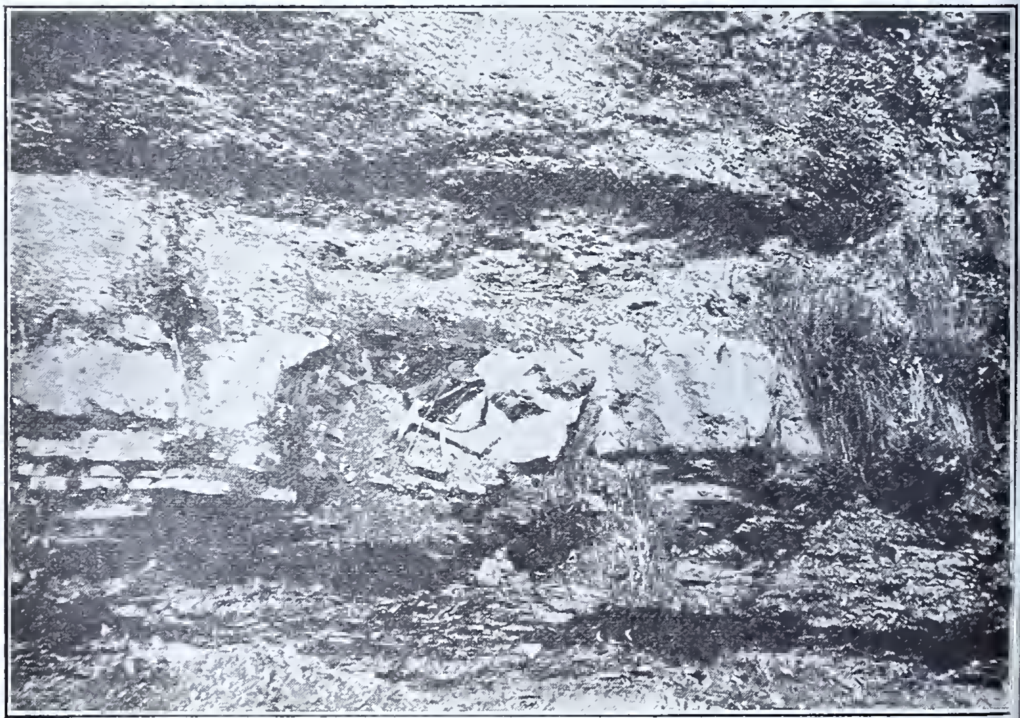
Section at Union Sewer Company's quarry.

	Ft.	in.
Limestone, fossiliferous, Ames		
Clay and clay-shale, red	18	
Shale, greenish-yellow	16	
Clay, gray, but weathers red	4	8
Shale, gray at base, greenish-yellow towards top	48	
Limestone, fossiliferous, impure, Woods Run		2½
Coal		2 to 4
Clay, gray	5	5
Shale, greenish-yellow, weathers red	4	
Limestone, impure, Woods Run (?)		2½
Clay, olive-drab, weathers red	3	2
Shale, greenish-gray	32	5
Limestone, sandy, fossiliferous, Pine Creek		7 to 15
Buffalo sandstone	25+	

Plate XII



A. Lower Saltsburg shale, Pine Creek limestone, and Buffalo sandstone at mouth of Dead Man's Hollow, opposite Versailles.



B. Pine Creek limestone on Pine Creek above Etna.

A careful search for fossils in the lower limestone bed was made both here and near Trafford City, but none were discovered. The exceedingly impure character of the limestone doubtless accounts for this. In the valley of Long Run between Youghiogheny River and B. M. 815 and also in Snake Hollow, the next valley to the north, both the Woods Run limestone and the coal are exposed at a number of places and they proved very useful in determining the structure of the rocks in that locality. The interval from the Ames to the upper Woods Run limestone or coal at Versailles ranges from 90 to 100 feet; at Trafford City the interval is 95 feet.

Pine Creek limestone. This marine limestone is stratigraphically the lowest which outcrops within the boundaries of the quadrangle. It is found only where Youghiogheny River and Turtle Creek have cut deep into the Murrysville anticline, and near the north boundary of the quadrangle where Allegheny River and its tributaries have cut equally deep into the Amity anticline and the rapidly rising strata in Shaler township. In the latter district, north of Millvale, the limestone is first seen in the stream-bed a quarter of a mile southeast of B. M. 804. Following this stream and Evergreen Road to the northwest, the limestone is again well exposed about a third of a mile northwest of B. M. 804 at a small quarry which at one time was operated in the Buffalo sandstone, immediately underlying the Pine Creek limestone. Where first seen in the stream-bed, the limestone is 8 inches thick, gray, brittle, sparingly fossiliferous, contains small flakes of biotite which give it a speckled appearance, and weathers to a reddish color. At the quarry little more than half a mile away it is 21 inches thick, hard and sandy, and merges into the massive sandstone below it. Only two hundred yards or so to the west, and less than a fifth of a mile north of the quadrangle boundary, it is 6 inches thick and underlain by 15 feet of clay. A hundred yards farther and one finds only 2 inches of limestone, again underlain by clay.

The limestone may be seen again in its typical sandy, sparingly fossiliferous aspect along the Baltimore & Ohio tracks at the north boundary of the quadrangle and within the borough limits of Etna. At this point it is 18 inches thick and directly above massive Buffalo sandstone.

The top of the limestone is exposed in the bed of the little stream which flows into Allegheny River at Nadine. Its appearance here is similar to its appearance southeast of B. M. 804, Shaler township, and to its appearance in the little valley half-way between Sandy Creek Station and Verona. In the latter place it is gray, brittle, apparently quite pure and almost non-fossiliferous; in fact, pink crinoid plates were the only fossils that could be found.

A very good exposure of the Pine Creek limestone occurs at Glenover on the west side of Allegheny River about half a mile north of the quadrangle boundary. There the limestone is hard and sandy and changes rapidly in thickness from a few inches to a maximum of 33 inches.

The best locality for the collection of fossils is the vicinity of Trafford City. There the limestone is fairly pure, fossils are abundant, and the outcrop of the limestone is quite extensive. Moreover in that vicinity fossils are fairly abundant in the shale above the limestone and can be dug from the shale in a good state of preservation. In the vicinity of Versailles the limestone is again very hard and massive and the fossils are generally broken. In this locality also one may view the rapid change in the strata below the Pine Creek limestone. On the north side of Dead Man's Hollow, which is west and across the river from Versailles, the limestone is underlain by 2½ feet of sandy shale and then sandstone. On the south side of the same hollow the limestone merges directly into the sandstone. Half a mile north, at the mouth of Snake Hollow, it is underlain by at least 8 feet of clay, the base of the bed being concealed.

The appearance of the limestone in its different outcrops has been rather fully described because of the importance of this bed as a "key" rock in mapping structure, and because in the past it has frequently been confused with the Brush Creek limestone which occurs 65 to 95 feet below it and which does not outcrop within the limits of this quadrangle.

Certain types of fossils, particularly productus and spirifers, are rather common in the Pine Creek limestone and stand out prominently on weathered surfaces. These fossils also serve to distinguish the Pine Creek from the Ames and Brush Creek limestones.

The Pine Creek limestone occurs from 45 to 55 feet below the upper Woods Run limestone, and from 127 to 178 feet below the Ames. In general the intervals are progressively less from east to west; the one radical exception being that in the vicinity of Terrace, Mifflin township, the interval from Ames to Pine Creek is greater than anywhere else nearby. The decrease in interval from there towards Hays is very rapid.

Buffalo sandstone. This is the lowest stratum exposed in the quadrangle. At the quarry of the Union Sewer Pipe Company 25 feet of massive, cross-bedded, gray sandstone is exposed. About 12 feet of massive sandstone outcrops along Brush Creek near the east boundary of the quadrangle and the same thickness is exposed just north of Trafford City where Turtle Creek bends sharply to the north. Between Sandy Creek and Verona the sandstone is more evenly

bedded and the beds are thinner. At Verona the whole member is exposed and it is seen to include 25 feet of thin-bedded to massive-bedded sandstone.

SUB-SURFACE ROCKS.

CONEMAUGH GROUP.

Brush Creek limestone and coal. Judging from the evidence afforded by over 40 diamond drill-holes the Brush Creek limestone in this region is frequently lacking from the section, its horizon being marked only by dark, fossiliferous shale. The Brush Creek coal however, is a very persistent bed and is mentioned in the records of most of the holes. It is never more than 12 inches thick, hence its economic importance is negligible; but to the geologist it is a valuable stratigraphic "marker." It occurs from a few inches to 20 feet below the Brush Creek fossiliferous zone and from 69 to 111 feet above the Upper Freeport coal.

Mahoning coal. The Mahoning coal is thin and worthless in the Pittsburgh quadrangle. Although 21 inches of coal is recorded in one drill-hole about two-thirds of a mile north of Clugston, other drill-holes in the vicinity show that this maximum thickness is of very local extent. The coal is recorded usually at 35 to 45 feet above the Upper Freeport coal.

Mahoning sandstone. Records of numerous drill holes plainly show that the Mahoning sandstone is extremely variable in thickness, and also that the position of the main body of sandstone is quite variable. Most often the latter is found below the Mahoning coal, or its horizon, and not far above the Upper Freeport coal. Frequently the sandstone occupies the middle part of the interval between the Brush Creek coal and the Upper Freeport, and the Mahoning coal is not represented. Occasionally 20 feet or more of sandstone is found between the Brush Creek and Mahoning coals. The records of some churn drill-holes show as much as 100 feet of Mahoning sandstone, but this great thickness is somewhat doubtful inasmuch as 76 feet is the greatest thickness noted in any of the diamond drill-holes of which the author has record. This thickness of 76 feet occurs at Center and is apparently quite local as other drill-holes in the vicinity show 59 feet and less of the same sandstone. The average thickness of the main body of sandstone is approximately 35 feet.

In some parts of the quadrangle the Upper Freeport coal was eroded in the period of land emergence which terminated the Allegheny epoch. In those places the Mahoning sandstone is now found lying directly on the strata which formerly were below the Upper

Freeport. This condition exists in a few places near Versailles, where ordinarily the coal is present, 6 to 7 feet thick. In the Hubbard mine of the McKeesport Coal & Coke Company, located near the mouth of Long Run, one can see this unconformity and can examine the Mahoning sandstone in place. It can be examined with less trouble, however, on the dump across the road from the mine. As seen there, it is a medium-grained, gray, arkosic sandstone, with small flakes of muscovite scattered through it, its appearance being so similar to that of the other massive sandstones occurring in the Conemaugh as to defy identification except in place.

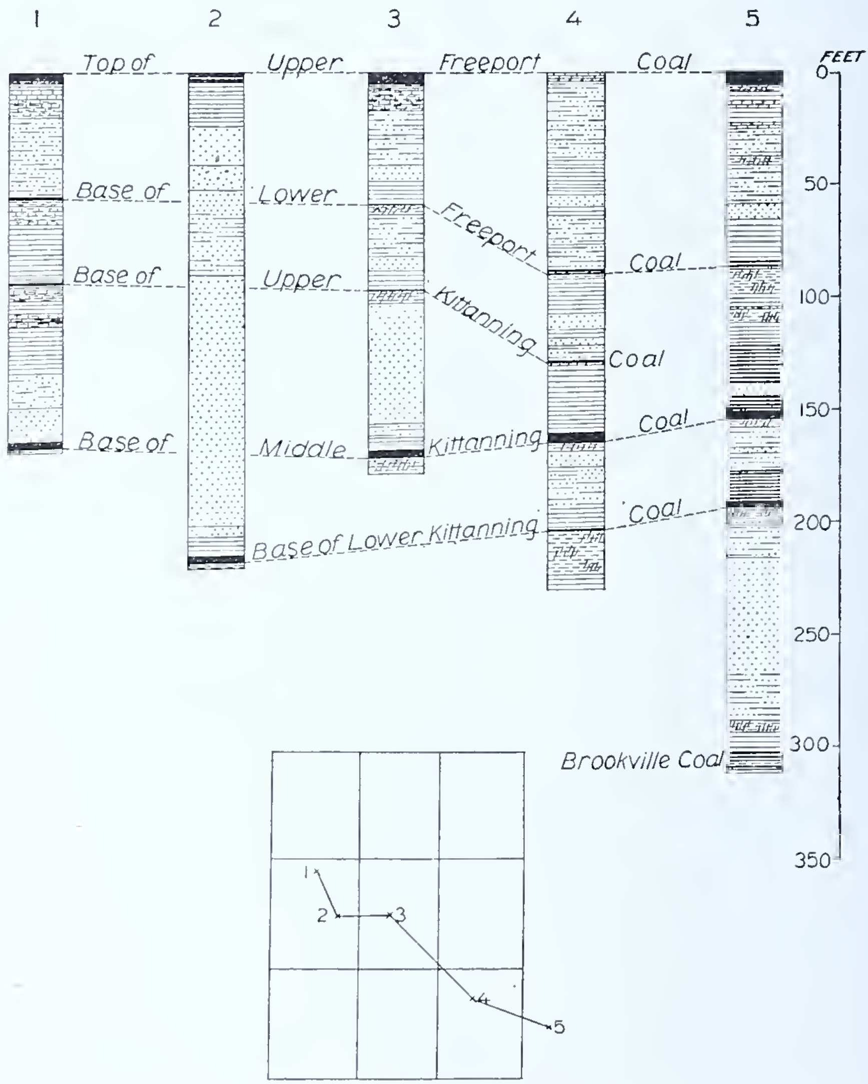


Figure 14. Diamond drill-hole sections of the Allegheny group.

1. Near mouth of Beaks Run, Baldwin township.
2. 1 mile south of Hays, Mifflin township.
3. ½ mile south of Terrace, Mifflin township.
4. Greenock, Elizabeth township.
5. Rillton, Sewickley township.

ALLEGHENY GROUP.

Judging from the information afforded by drill-holes there is little change in the thickness of the Allegheny group from one part of the quadrangle to another, 300 feet being about the average. The intervals between beds within the group, however, vary considerably. This variation is particularly marked in the case of the interval between the Upper Kittanning and Middle Kittanning coals, which is only 40 feet in the southeast part of the quadrangle and 70 feet in the west-central part. The great variation in this interval is apparently caused by a change in the character of the strata between the two coals; the sandstone of the west part of the quadrangle representing a lesser thickness of shale in the east. This change is rather strikingly shown in Figure 14.

POTTSVILLE SERIES, MAUCH CHUNK SERIES, AND LOWER ROCKS.

Knowledge of these rocks is confined solely to the rather unreliable information derived from churn drill-holes. Such data would indicate that the Pottsville series is from 125 to 200 feet thick, and that the Mauch Chunk series ranges from 0 to 125 feet thick. It is apparently certain that the Mauch Chunk red shale, by which this horizon is usually detected in drill records, is lacking in the northwest part of the quadrangle, in Snowden and Union townships, and in the greater part of Mifflin and Jefferson townships. It occurs in thin and isolated patches in the northeast and central parts of the quadrangle and in the southeast is fairly persistent. This "pinching out" of the Mauch Chunk red shale is another example of the westward thinning of practically all the sedimentary strata which outcrop in the central and western parts of the State. The general character of the Mauch Chunk, Pottsville and lower rocks is shown in Plates XX, XXI, and XXII.

STRUCTURE.

The physical characteristics of the rocks as seen close at hand were described under the heading STRATIGRAPHY. The folding of the rocks, their attitude or "lay" with respect to one another, and the faulting or breaking of the beds, is a separate part of geology and must be viewed in a broader way if the significance of these relationships is to be understood.

FOLDING.

If the rocks in the vicinity of Pittsburgh were all horizontal, there would originally have been more Pittsburgh coal within the limits of the city of Pittsburgh than in either Elizabeth or Jefferson town-

ships. Everyone familiar with the coal industry in the Pittsburgh region knows that only a small part of the city is underlain by this coal. Actually the original tonnage in Jefferson township was more than triple that in Pittsburgh, and Elizabeth township contained more than five times as much coal. The reason for this unequal distribution of coal is that the rocks in the Pittsburgh region, though dipping locally in different directions, tend to rise towards the north, and hence an equal amount of erosion has removed more of the Pittsburgh coal in the northern part of the quadrangle than in the southern. This same general dip to the south is shown throughout the western part of the State. More locally the rocks dip usually either to the northwest or to the southeast. This is because the rocks have been folded into structures with a general northeast-southwest trend, the dip of which is usually more pronounced than the regional dip just mentioned. In the Pittsburgh quadrangle there are two broad up-folds or anticlines, and two down-folds or synclines. The position of these folds is shown on the structure map (see Plate III) by means of contour lines drawn on the base of the Pittsburgh coal. Each contour line is so drawn that all points on it are at the same elevation above mean sea-level. The contour interval is specified as 25 feet. That means that between any two structure contour lines, the elevation of the Pittsburgh coal rises or falls 25 feet, depending upon the direction of dip. As the elevation of the coal at any point is shown by the structure contour lines, the position of the coal with relation to the surface may be determined by finding the elevation of the surface at the same point. If the surface is 1100 feet above sea level and the contour line on the coal is 900 feet at the same point, then the coal is 200 feet below the surface. Where the elevation of the coal is higher than the surface, the Pittsburgh coal has been removed by erosion. It should be understood that although the contour lines are shown as unbroken lines on the structure map, the Pittsburgh coal at the elevations represented may be below the surface, may outcrop, or may have been eroded.

Because of the non-parallelism existing between the Pittsburgh coal and strata occurring above and below it, the structure map was based as far as possible on elevations obtained on the outcrop of the coal or on elevations obtained from mine maps which were deemed reliable. The extended outcrop of the coal facilitated this purpose greatly. In areas where the coal has been eroded, elevations were obtained on certain "key" beds, chiefly the Ames, Woods Run, and Pine Creek limestones and the Duquesne coal. The elevation of the Pittsburgh coal was then determined by adding to the elevation obtained the correct interval from the specific key bed to the Pittsburgh coal. The base of the Benwood limestone was used similarly in a few

small areas where the Pittsburgh coal is deeply buried, the interval in such cases being subtracted from the elevation obtained.

Description of major structures.

McMurry syncline. This is the broad, gently folded structure which rises gradually from the point where it enters the quadrangle, northwest of Broughton, until the Lawrenceville district in Pittsburgh is reached. In that district there is a small reversal of dip as shown by the closed contour marked 1050. The bearing of the structure, which is about N. 10° E. from the quadrangle boundary to Pittsburgh, here swings to the northeast, the axis of the structure passing through the lower part of Allegheny Cemetery and the middle of Sharpsburg. As shown by the contours, the Pittsburgh coal is raised 270 feet along the axis of this structure within the limits of the quadrangle.

Amity anticline. The general trend of this structure is about N. 30° E. The axis of the structure crosses the western boundary of the quadrangle a quarter of a mile north of the boundary line between Washington and Allegheny counties. Passing through Wallace, Lincoln Place, and Homestead, it swings north at Swissvale and then makes rather an abrupt turn to the northeast in the Blackadore Avenue district, north of Wilkinsburg. Southwest of Lincoln Place, the top of the structure is undulating, three small domes occurring between that place and the western boundary. From Lincoln Place to Edgewood there is a fairly steady rise in the structure of about 27 feet to the mile. From Edgewood to the Blackadore Avenue district the rise is much less rapid, averaging about 7 feet to the mile. Southeast of Nadine the structure rises sharply, only to flatten out again near the mouth of Sandy Creek. From there to Verona the rise is at the rate of 50 feet per mile.

Duquesne syncline. This complicated structure crosses the south boundary of the quadrangle west of Monongahela River, passes through Camden, Dravosburg, Duquesne, Turtle Creek and Center, and finally passes beyond the east boundary of the quadrangle between the latter village and New Texas. The axis of the structure is not so easily traced. From the south boundary of the quadrangle to Coal Valley the structure is shaped like the lip of a spoon and the axis is almost a straight line. Between Coal Valley and Duquesne, however, there is a low roll in the bottom of the syncline, the existence of which was suspected early in the course of field work, but which was not definitely proven until plane-table work confirmed earlier barometric observations. At East Pittsburgh the structure is again complicated by the appearance of minor folds which diverge to right and left of the main structure. Near Linhart the latter makes

a sharp bend to the north, thus forming a prominent nose in the structure near that place and providing an excellent place for the accumulation of the oil which was discovered there in 1922. Northeast of the junction of Thompson Run and Lake Run the structure is again fairly regular, the rocks rising at a rate of about 28 feet per mile. The total rise from where the axis of the syncline crosses the southern boundary to where it crosses the eastern boundary is 380 feet.

Murrysville anticline. The Murrysville anticline is the most prominent structural feature in the quadrangle. From the bottom of the Duquesne syncline at Duquesne to the top of the Murrysville anticline, measuring straight up the dip, the rocks rise 275 feet. On the southeast side of the anticline the rise is still greater, being 450 feet in a distance of 4¾ miles. From where Monongahela River crosses the southern boundary of the quadrangle to West Elizabeth, the pitch of the anticline measured along the axis is fairly steep, the rocks rising about 130 feet in 1½ miles. Between West Elizabeth and Clairton the pitch is considerably less, this structural terrace no doubt accounting for the long life of the gas wells in that area. From the west end of Clairton to Belle Bridge the rise is again rapid, slacking off between the latter place and Versailles. Northeast of Versailles the top of the anticline broadens a little, narrowing again past the junction of Jacks Run and Long Run. The whole structure has played an important part in the accumulation of gas in pools in the southeast part of the quadrangle.

Minor folds.

Many folds were observed in the course of field work which were too nearly flat or too restricted in extent to be adequately shown on the structure map. These minor folds could only be shown by using a large scale map and a very small contour interval. Since they are relatively unimportant and since such fine work would have involved the use of the plane table in determining all elevations and thus have added greatly to the cost of the work, such a map was not prepared except in the heart of the McKeesport gas field (see Pl. XXV), where it was hoped that detailed work might give some explanation of the very large production of natural gas obtained there. In preparing that map the location and elevation of each outcrop of the three fossiliferous limestones occurring there was obtained and plotted. The rather extensive outcrops gave overlapping structure contours which plainly show the non-parallelism of these beds and the futility of attempting to map the structure very closely where more than one bed must be used in making the map. It is interesting also to note the different positions of the axis of the anticline as

based upon each of the three fossiliferous limestones and as based upon the top of the Speechley sand. According to the structure plotted from surface outcrops, the crest of the anticline crosses Long Run at about the same point as the south boundary of Olympia Park; whereas drilling showed that the axis of the sub-surface structure crosses Long Run 600 feet north of the north boundary of the park. The detailed work also brought to light the small downfold on the

PLATE XIII.

Fault in the Birmingham shale and sandstone at McKeesport.

Nearer view of fault at McKeesport shown above.

southeast flank of the anticline and the projecting nose on the northwest flank, neither of which features had been discovered by barometric work.

FAULTING.

The few faults observed in this quadrangle are all of local extent and small throw. The most conspicuous case of faulting occurs in the bluff above the P., McK. & Y. RR tracks near the mouth of Youghiogheny River where massive beds of sandstone have been fractured and displaced, the maximum throw being about 15 feet. Vertical faulting (?) was noticed in this same horizon near the mouth of Peters Creek where fractures occur in the shale but do not pass through a sandstone bed which caps it.

At a point about one-third mile northeast of the Pennsylvania Railroad tracks and in the valley which divides Rankin, a thrust fault with a throw of 7 feet was observed at the base of the Morgantown sandstone. Another small thrust fault was seen in the Connellsville sandstone on the Pittsburgh pike, half a mile west of West Elizabeth.

A very sharp fold occurs at the top of the Amity anticline, from the Blackadore Avenue district north of Wilkinsburg, to Verona; and it is believed that this folding is accompanied by faulting, although the evidence is not conclusive. On the road from Nadine to Sandy Creek there is a very suspicious reversal of dip about a quarter of a mile east of B. M. 1108. Exactly one mile west of south from the latter point a saddle occurs in the Pittsburgh coal although the mine pit where this was noted is close to the crest of the anticline. Half a mile southeast of Verona at the crest of the anticline, a sharp reversal of dip is accompanied by what appears to be faulting, a drop of 14 feet occurring between outcrops of the Pine Creek limestone only 200 feet apart.

UNCOMFORMITIES.

There are two general types of unconformities, those in which the dip of adjacent strata is different, implying a time interval between the deposition of the two strata in which the earlier strata were tilted; and those in which the unconformity is marked by an undulating surface, indicating a period of emergence and erosion before the deposition of the later beds. In the Pittsburgh quadrangle most of the unconformities noted belong to the latter type, although the frequent occurrence of cross-bedded strata might make it appear otherwise in a casual study. Cross bedding is a common phenomenom in all of the sandstones outcropping in this quadrangle—in fact it is

A. Base of Morgantown sandstone south of Sandy Creek.

B. Irregular base of Saltsburg sandstone in bluff near the mouth of Pine Creek at Etna.

the usual condition. In the Birmingham shale and sandstone it is occasionally very marked and only a thorough examination will dispel the conviction that unconformities occur within this horizon.

In Pigeon Hollow, west of Boston and a third of a mile southwest of B. M. 793, an unconformity of dip was noted in the Birmingham shale about midway between the Duquesne coal and the Wellersburg coal. The difference in dip of the shale above and below the unconformity is about 10°. A similar unconformity was noted in the shale just above the Ames limestone at a point about half a mile east of the south end of the Boston bridge. Both of these seeming unconformities may possibly represent only another phase of the cross-bedding above referred to; although it is difficult to visualize the formation of cross-bedding in shale, a quiet water deposit.

Erosional unconformities are frequent and occur at a number of horizons in the Conemaugh group and at two or more horizons in the Monongahela. One and a half miles east of Linhart a marked unconformity was noted at the base of the clay which underlies the Sewickley coal horizon (here represented by carbonaceous shale). Between Dravosburg and Duquesne, the Sewickley sandstone lies directly on the Redstone clay, the coal apparently having been eroded before the deposition of the sandstone. This same unconformity may be viewed on the road between Coal Valley and Lewis Run. Near B. M. 1057, between McKeesport and East McKeesport, the Upper Pittsburgh sandstone has been quarried on a small scale and an unconformity at the base of that sandstone is well exposed there.

In the Conemaugh group erosional unconformities were frequently noted at the base of the Connellsville and Morgantown sandstone, in the Clarksburg horizon, at the top of the Saltsburg sandstone, and at the base of the Pine Creek limestone. Unconformities were occasionally noted at the top of the Connellsville sandstone, the base of massive beds of Birmingham sandstone, the base of the Grafton sandstone and the base of the shale which in a few places underlies the Ames limestone. The unconformity between the Conemaugh and Allegheny groups has previously been described.

The erosional unconformities at the base of the Morgantown sandstone and at the top of the Saltsburg sandstone were observed in so many places as to leave little doubt that these unconformities represent periods of widespread land emergence. The land could not have been raised much above sea-level however as the relief shown by the unconformable contacts is slight.

Perhaps the most interesting unconformity in the Conemaugh is exposed in the valley of Lewis Run, Jefferson township, about half a mile north-northeast of B. M. 1086. At that point the Clarksburg

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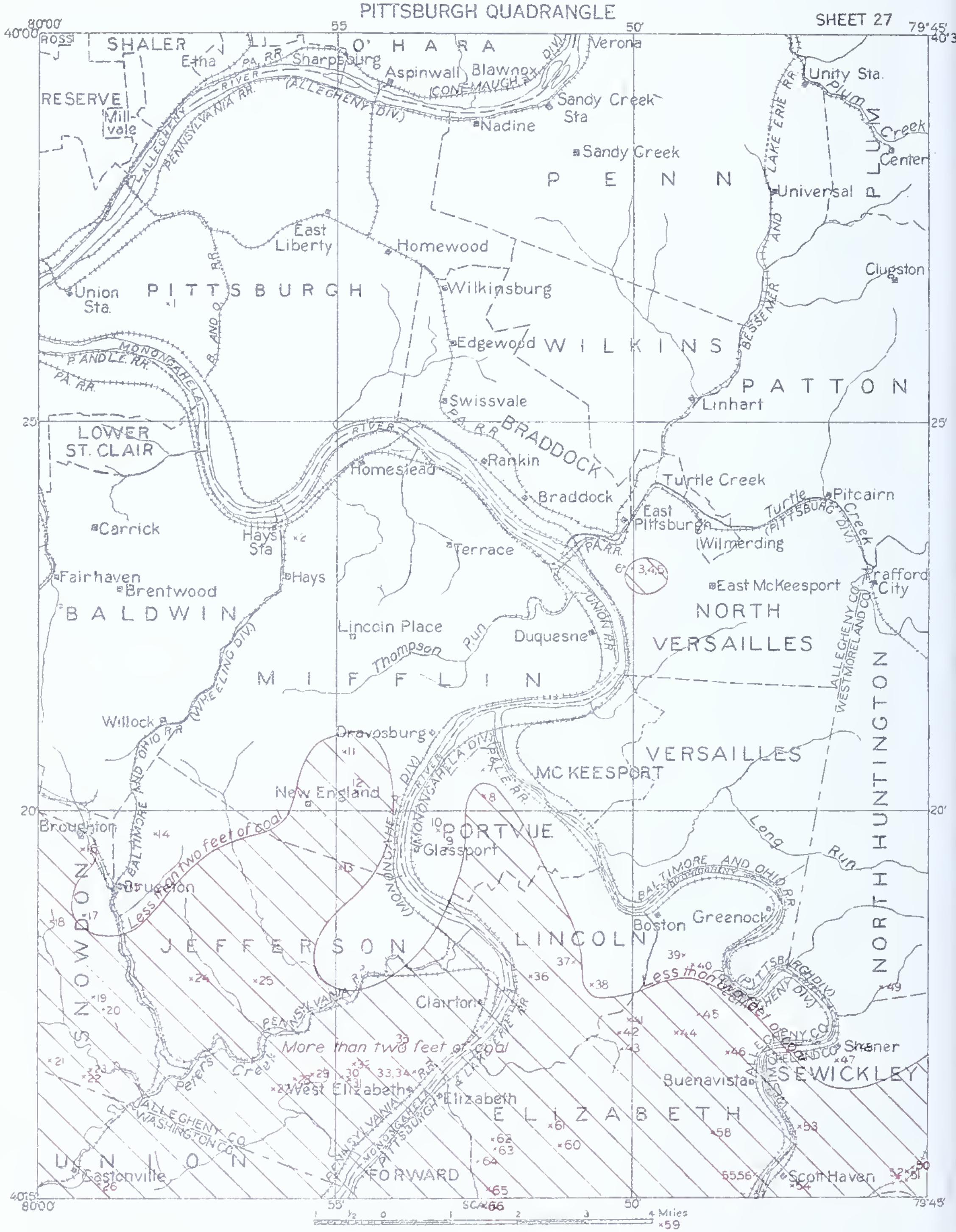
PITTSBURGH QUADRANGLE

SHEET 27



Numbers refer to sections of the Redstone coal shown in figures 15 and 16

PLATE XV. AREA IN WHICH THE REDSTONE COAL IS MORE THAN TWO FEET THICK

limestone has been cut through almost vertically and an unstratified greenish-gray clay has been deposited in its place. Only one side of the cut is exposed but it is evidently rather narrow as the limestone is again found in place a hundred feet or so up the valley. The sharp line of the contact between the limestone and the clay would seem to indicate that the limestone had been thoroughly consolidated before it was raised above sea-level, and the angle of the contact would indicate that the channel was cut by a fairly swift stream.

MINERAL RESOURCES.

Since the Pittsburgh quadrangle is in one of the most thickly settled districts in the State, it is natural that development of the resources within the quadrangle has been going on for very many years, and that some of the most valuable resources, the Pittsburgh coal bed and the mineral fuels, petroleum and natural gas, have been thoroughly prospected and already depleted to a considerable extent. The time is now at hand when other coal beds must be called upon to augment the supply from mines in the Pittsburgh coal bed and when attention should be called to the value of other resources not so well known.

COAL.

Of the coals outcropping within the limits of this quadrangle only two are of economic importance; namely, the Redstone and the Pittsburgh. Of the lower coals, the Upper Freeport is the most important and within a few years the output of coal from that bed will be greatly increased. The Middle Kittanning and Lower Kittanning coals are reserves which will not be touched until a much later day, owing to the depth at which they lie.

Redstone coal.

Although it is present at a number of points in the north half of the quadrangle, the Redstone coal is thick enough to be mined in only two or three small areas north of latitude 40° 26′ N. (see Plate XV). South of that latitude the coal is bright, hard, and blocky, and usually free of thick partings. It is underlain by clay or soft shale and overlain usually by similar soft beds. Occasionally sandstone is found just above the coal.

Analyses of the coal show that it compares favorably with the Pittsburgh coal and the Upper Freeport in its moisture and sulphur content, but that it is too high in ash to compete with those coals in a "buyers' market". The coal will continue to be mined in country banks for local use therefore, but competition will probably prevent larger mines from operating except in a "sellers' market."

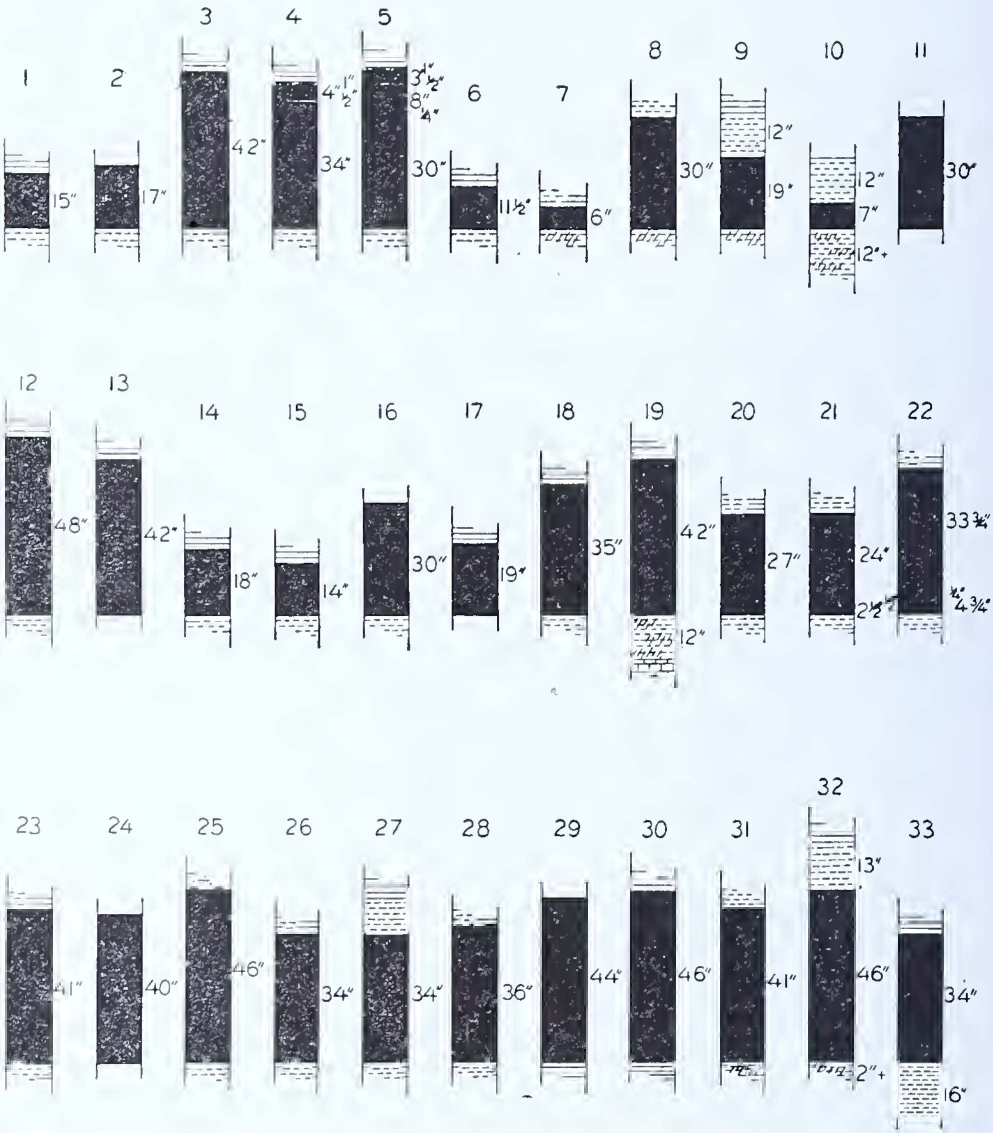


Figure 15. Sections of Redstone coal bed.

Fig. 15. Sections of Redstone Coal.

1. Outcrop on Darragh Street, Oakland district, Pittsburgh.
2. Outcrop near top of hill east of Hays station.
3. Crestas mine, Crestas Coal Company, 1 mile E-SE. of Port Perry, North Versailles township. Section 100 yards from entrance to mine.
4. Same as last. Section 400 feet SW. of entrance to mine.
5. Same as last. Section 300 feet S. of entrance to mine.
6. Outcrop $\frac{3}{4}$ mile E-SE. of Port Perry, North Versailles township.
7. Outcrop $\frac{1}{4}$ mile NE. of B. M. 1059, near Otto and Portvue, Portvue township.
8. Outcrop $\frac{1}{4}$ mile S.-SE. of B. M. 1059 near Otto and Portvue, Portvue twp.
9. Outcrop between B. M. 1094 and Glassport, Portvue township.
10. Prospect entry on hillside above north end of Glassport, Portvue township.
11. Prospect entry 1 mile NW. of Camden, Mifflin township.
12. Outcrop $\frac{3}{4}$ mile W. of Camden, Mifflin township.
13. Outcrop $\frac{3}{4}$ mile W.-NW. of Coal Valley, Jefferson township.
14. Outcrop $\frac{3}{4}$ mile northwest of B. M. 1173, near Option, Baldwin township.
15. Outcrop 200 yards east of Bruceton, Jefferson township.
16. Outcrop on main road south end of Broughton, Snowden township.
17. Outcrop $\frac{1}{2}$ mile west of mouth of Mineral Creek, Jefferson township.
18. Outcrop 1 mile W-SW. of Bruceton, Jefferson township.
19. Outcrop $\frac{3}{4}$ mile SW. of Wallace, Jefferson township.
20. Outcrop 1 mile NW. of Snowden, Snowden township.
21. Outcrop $\frac{3}{4}$ mile south of B. M. 928, Snowden township.
22. Shipping mine, abandoned (?) $1\frac{1}{2}$ miles north of Gastonville, Union twp.
23. Same as last. Section 150 feet from mouth of main haulage entry.
24. Outcrop $\frac{1}{2}$ mile E-SE. of Gillhall, Jefferson township.
25. Outcrop 1 1/10 miles east of Gillhall, Jefferson township.
26. Outcrop $\frac{1}{4}$ mile E-SE. of B. M. 926 at Gastonville, Union township.
27. Outcrop $\frac{3}{4}$ mile east of B. M. 1004 in Jefferson township between Lodds Run and Peters Creek.
28. Country bank, 1 mile east of B. M. 1004 in Jefferson township between Lodds Run and Peters Creek.
29. Country bank, 1 mile NW. of Jones Station, Jefferson township.
30. Outcrop $\frac{1}{2}$ mile SW. of B. M. 1101 near West Elizabeth Jefferson township.
31. Country bank, 1/3 mile S-SW. of B. M. 1101 near West Elizabeth, Jefferson township.
32. Country bank, $\frac{1}{4}$ mile S. W. of B. M. 1101 near West Elizabeth, Jefferson township.
33. R. W. Rowland country bank, West Elizabeth, Jefferson township.

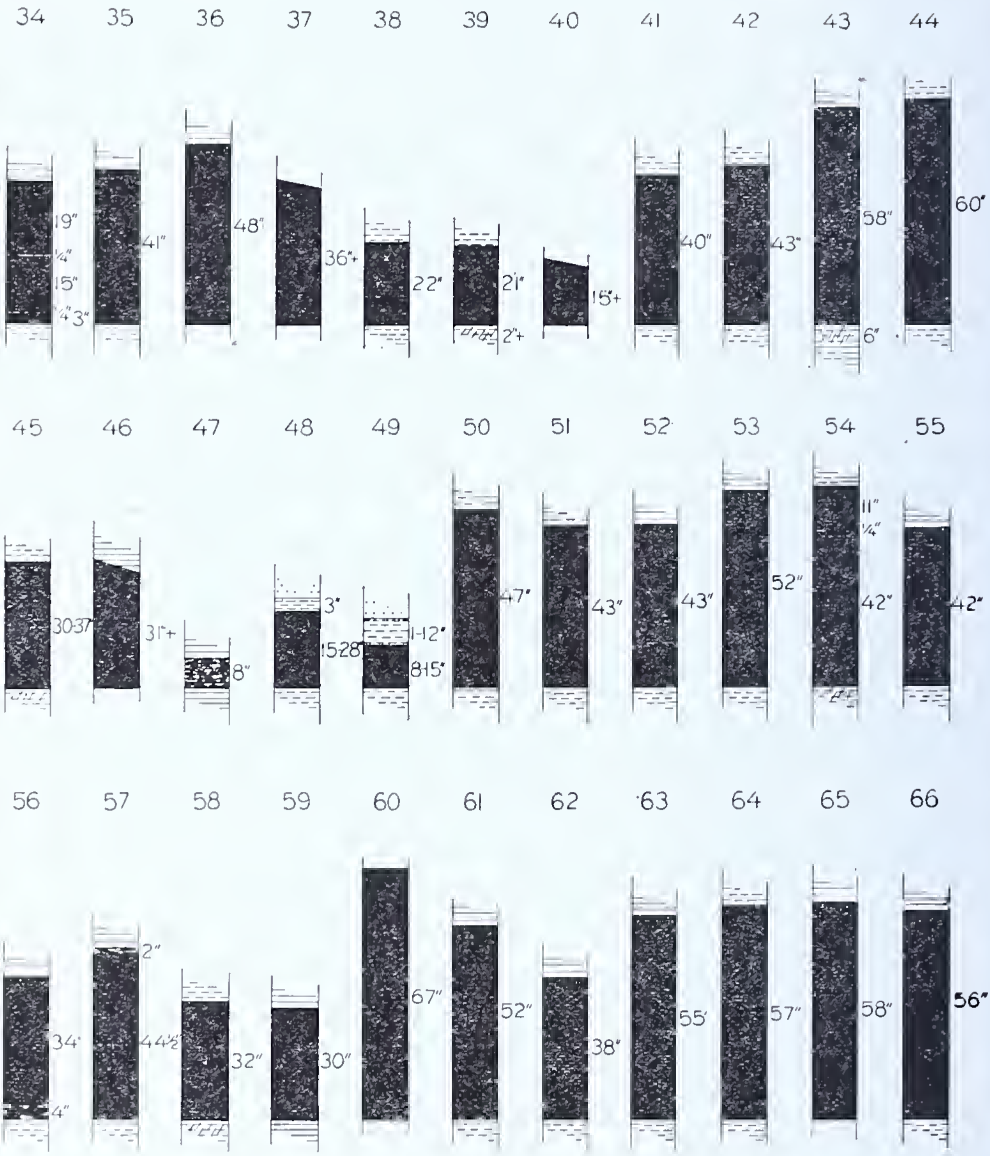


Figure 16. Sections of Redstone coal bed.

Figure 16. Sections of Redstone Coal.

34. Same as last. Section 400 ft. northwest of entrance.

35. Country bank, abandoned, north side of valley between West Elizabeth and Clairton., Jefferson township.

36. Outcrop ½ mile SE. of Belle Bridge, Lincoln township.

37. Outcrop 300 yards NE. of B. M. 1195, east of Belle Bridge, Elizabeth township.

38. Outcrop at schoolhouse ½ mile SE. of B. M. 1195, near Belle Bridge, Lincoln township.

39. Outcrop 1 mile SE. of Boston and one-fifth of a mile northwest of B. M. 1156, Elizabeth township.

40. Outcrop 300 yards NE. of B. M. 1156 and about 1 mile SE. of Boston, Elizabeth township.

41. Country bank, abandoned, 1/3 mile N-NE. of B. M. 1036, in upper part of Wiley Run Valley, Elizabeth township.

42. Country bank, abandoned, 1/5 mile north of B. M. 1036 in upper part of Wiley Run Valley, Elizabeth township.

43. Outcrop 100 feet south of B. M. 1036 in the upper part of Wiley Run Valley, Elizabeth township.

44. Outcrop 50 yards north of B. M. 936 and about 1½ miles NW. of Buenavista, Elizabeth township.

45. Prospect entry 150 yards SE. of B. M. 1032 and 1¼ miles NW. of Buenavista, Elizabeth township.

46. Outcrop 2/3 mile NW. of Buenavista, Elizabeth township.

47. Outcrop ¼ mile south of Shaner, Sewickley township.

48. Country bank, ¼ mile east of fork in road at Shaner, Sewickley township.

49. Prospect entry in stream bank ¼ mile west of B. M. 907, near Yohoghany, Sewickley township.

50. Country bank, Cowansburg, Sewickley township.

51. Country bank, 100 yards west of last.

52. Vissat mine, Sewickley Coal Company, Cowansburg, Sewickley township.

53. Gilbert mine, Leroy Coal Mining Company, ¾ mile north of Scott Haven, Sewickley township.

54. Country bank, abandoned, ½ mile E.-SE. of Scott Haven, Sewickley township.

55. Scott Haven mine, Scott Haven Coal Company ½ mile north of south boundary of quadrangle and across the river from Scott Haven, Sewickley township. Section near entrance of mine.

56. Same as last. Section at face of No. 2 east room.

57. Outcrop in bank beside new concrete road, west side of Youghiogheny River at south boundary of quadrangle.

58. Outcrop at B. M. 888, about 1 mile SE. of Buenavista, Elizabeth township.

59. Outcrop 1 mile S-SW. of B. M. 1117 in the southeast part of Elizabeth township. (Brownsville quadrangle).

60. County bank, shaft operation at B. M. 974, 2 miles E-SE. of Elizabeth.

61. Country bank, abandoned, 1¼ miles east of Hayden Run and 1 mile south of Wiley Run.

62. Country bank, east branch of Hayden Run, 1 mile SE. of Elizabeth.

63. Country bank, opposite side of hollow (south side).

64. Country bank, main branch Hayden Run., about 1 mile SE. of Elizabeth.

65. Country bank, 200 yards north of the south boundary of the quadrangle and 350 yards east of Hayden Run.

66. Country bank east side of Hayden Run at B. M. 857, just south of the south boundary of the quadrangle.

Analyses of Redstone coal.

[H. M. Cooper, U. S. Bureau of Mines, analyst]

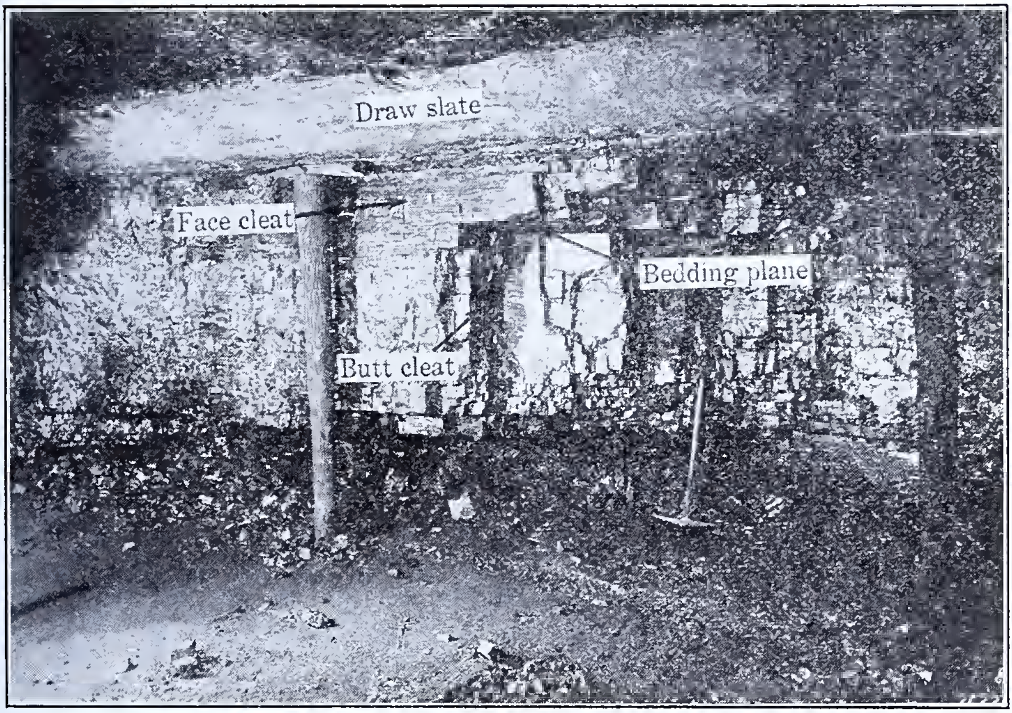
Mine, locality and sample number	Proximate, as received		Ultimate, as received		Calorific value	
					Calories	B.t.u's.
Crestas wagon mine, 1 mile south of East Pittsburgh Composite No. 85,904	Moisture Vol. matter Fixed carbon Ash	2.4 34.8 51.7 11.1	Sulphur Hydrogen Carbon Nitrogen Oxygen	2.3 5.2 71.8 .7 8.9	7,183	12,930
R. W. Rowland custom bank at West Elizabeth Composite No. 85,965	Moisture Vol. matter Fixed carbon Ash	4.4 32.0 54.2 9.4	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.0 5.5 71.8 1.4 10.9	7,089	12,760
Scott Haven mine, ¼ mile south of Scott Haven, Elizabeth township Composite No. 82,402	Moisture Vol. matter Fixed carbon Ash	2.6 34.0 52.6 10.8	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.8 5.1 72.0 1.5 8.8	7,222	13,000

In this quadrangle as elsewhere, the Redstone coal is cut by bands of clay which sometimes replace the coal for several yards. These do not, however, distort the coal on either side as such veins usually do in the Pittsburgh coal bed. They do, of course, add to the cost of mining, and their prevalence is a source of great annoyance to operators working this bed. Rolls in the roof are fairly frequent, but they are usually small and are less bothersome than the clay veins.

In times when the price of coal is very high, country banks are operated, idle mines are re-opened, and the production of coal from the Redstone bed assumes important volume. In normal times the production is small. Reese, formerly of this Survey, has estimated[18] that a total of 3,000,000 tons of Redstone coal has been mined in Allegheny County. The writer believes this figure much too small in view of the relatively large production in the years 1917 to 1921. A close estimate of the tonnage mined is almost impossible however, because of the large proportion of coal mined in small country banks where no effort is made to keep records of production. Reese also estimated that 79,200,000 tons of recoverable Redstone coal remained in the ground. To this figure should be added 8,900,000 tons for the Redstone coal occurring in the parts of Snowden and Union townships in the Pittsburgh quadrangle. The tonnage remaining in the Pittsburgh quadrangle alone is believed to be in excess of 60,000,000 tons.

[18] Reese, John F., Coal reserves in Allegheny County, Pennsylvania, Pa. Geol. Survey, Bull. 31, 1922.

PLATE XVI



Mine face of Pittsburgh coal.

Pittsburgh coal.

The areal extent of the Pittsburgh coal in this quadrangle is shown on Plate III. This same bed extends west into Ohio and south into Maryland and West Virginia. The vastness of the swamp in which the carbonaceous material was deposited which later was changed into the Pittsburgh coal, is difficult to conceive. Nothing like it exists today unless it be the tundras of northern Siberia and North America. Any attempt to estimate the original tonnage of Pittsburgh coal soon runs into figures which are staggering. In this State alone the tonnage still left in the ground is enormous. Even in the relatively small area of the Pittsburgh quadrangle, where the coal has been mined more than 165 years, there still remains a large tonnage.

In this area the coal is bright, blocky (with butt and face cleat well developed), fairly hard, and suitable for domestic use, for all steaming purposes, for the manufacture of gas, and in combination with other coals, in the manufacture of coke, and though not the best coal available for such purposes, it can be used for smithing. It is easily recognized in mines or in outcrop by its persistence, thickness, uniformity and the ever-present roof section above the main bed. The uniformity of the bed is probably its most striking characteristic. The coal occurs in two main benches, separated by the "bearing-in"

coal and thin clay or shale partings above and below the latter. Those same partings, though very seldom over one inch thick, can be found everywhere the coal is exposed.

The top inch or two of the upper bench and the bottom few inches of the lower bench may be high in sulphur or phosphorus and occasionally are not mined. Much more frequently the whole of the main bed is mined and used.

The coal is underlain by 0 to 3 feet of gray fireclay, the average thickness being less than one foot. A dark carbonaceous limestone usually underlies the fireclay and occasionally is found directly below the coal. The main bed is overlain by fireclay averaging 10 or 11 inches thick and that in turn by the so-called "roof" coal. Although this roof coal is not being mined or used now, it is believed that with further improvements in the use of pulverized coal and fine sizes, even this bony, high-ash fuel might be profitably mined in conjunction with the main bed. Coal with as much as 35 per cent ash has already been burned successfully in large power plants.

Although clay veins and horsebacks are not common in the Pittsburgh bed, they are encountered occasionally and as always are a source of annoyance to the miner and of increased cost to the mine owner. The clay veins vary greatly in appearance, sometimes cutting straight through the coal from top to bottom, more often cutting through the main bed at an angle, or even zigzagging in a path from draw slate to floor-clay. Frequently branches diverge from the main clay vein and ruin the coal for many feet on either side. "Slack veins" are encountered sometimes in "swamps" or at the foot of a rise but these are less common than clay veins and do not affect the coal on either side. Both clay veins and "slack veins" are results of the same cause; namely, the folding of the bed in minor ripples, superimposed upon the major folds. The clay veins occur where the coal has been under tensional or torsional strain, usually at the top of a roll, the slack veins where the coal has been compressed beyond its breaking point.

Figures 17 and 18. Sections of Pittsburgh Coal

1. Country bank, abandoned, ½ mile south of B. M. 804, north of Millvale.
2. Country bank, abandoned, ¾ mile SE. of B. M. 950 in Spring Garden hollow, Reserve township.
3. Country bank 1½ miles S-SW. from the south end of the Sharpsburg bridge.
4. Country bank above Booth & Flynn quarry, ⅓ mile NW. of the north end of the Brady Street bridge.
5. Fairhaven mine, abandoned, Pittsburgh Coal Company, South Side district, Pittsburgh.
6. Burke mine (country bank), Marion Coal Company, 1¼ miles W-NW. of the north end of the Homestead bridge.
7. Country bank, abandoned, Beechwood Boulevard, ½ mile N-NW. of the north end of the Homestead bridge.
8. Country bank, abandoned, Darlington Road and Beacon Street, Squirrel Hill, Pittsburgh.
9. Country bank, 1 mile SE. of the south end of the Brilliant-Aspinwall bridge.
10. Mine No. 2 (country bank), George E. Dash and Sons, ½ mile SE. of where the Pennsylvania Railroad tracks cross over the ravine at Edgewood.
11. Entry to abandoned mine, ½ mile S-SW. of B. M. 953 in Wilkins township, north of East Pittsburgh.
12. Country bank, 1 mile SW. of B. M. 1198, south of Sandy Creek, Penn township.
13. Country bank, ½ mile south of B. M. 1227, east of Sandy Creek, Penn township.
14. Country bank and small stripping operation, 100 yards NW. of B. M. 1206, east of Verona, Penn township.
15. Plum Creek mine, Harper Coal Company, entry 1 mile south by east of Uuity Station, Plum township.
16. Stripping operation ¼ mile southeast of Clugston cross-roads, Patton township.
17. Hall mine, abandoned, Hall Coal Company, ¼ mile south of B. M. 983, in the southeast corner of Penn township.
18. Country bank, 2 miles NE. of Turtle Creek borough.
19. Grinn mine, Grinn Coal Company, 1¼ miles S-SE. of Monroeville, Patton township.
20. Springhill miue (now a stripping operation), Export Coal Company, top of first hill west of Trafford City.
21. Country bank, 1 2/3 miles south of Brush Creek and abont 2½ miles south of Trafford City.
22. Michael and Gordon mine, 1 1/3 miles N-NW. of Greenock.
23. Country bank, abandoned, ¼ mile W. SW. of B. M. 1094, and about 1½ miles south of East McKeesport.
24. Country bank, abandoned, 2/3 mile south of the sharp bend in Turtle Creek between East Pittsburgh and Wilmerding.
25. John Elek country bank at Terrace, Mifflin township.
26. Country bank, abandoned, ½ mile NE. of the intersection of the Monongahela and Youghiogheny Rivers.
27. Camden mine, Camden Coal Company, ½ mile NW. of Camden, Mifflin township.
28. Frank Kochler country bank, 2/3 mile SE. of Lincoln Plaee, Mifflin township.
29. Smith mine, abandoned, Hays Gas Coal Company, ¼ mile south of Hays, Mifflin township.
30. Country bank, ¾ mile N-NE. of the north end of the Hays bridge.
31. Country bank in bluff overlooking river 9/10 mile S-SE. of the mouth of Becks Run.
32. Black Hills mine, Black Hills Coal Company, ¼ mile east of Fairhaven station, Baldwin township.
33. Country bank, 1 1/3 miles N-NE. of Willock, Baldwin township.
34. Mine No. 4, Pittsburgh Cannel Coal Company, 1 mile NW. of Broughton, Snowden township.
35. Montour No. 8 mine, Pittsburgh Coal Company, on Lewis Run, 1¼ miles SW. of New England, Mifflin township.
36. Bertha mine, Beam Coal Company, Bruceton, Jefferson township.

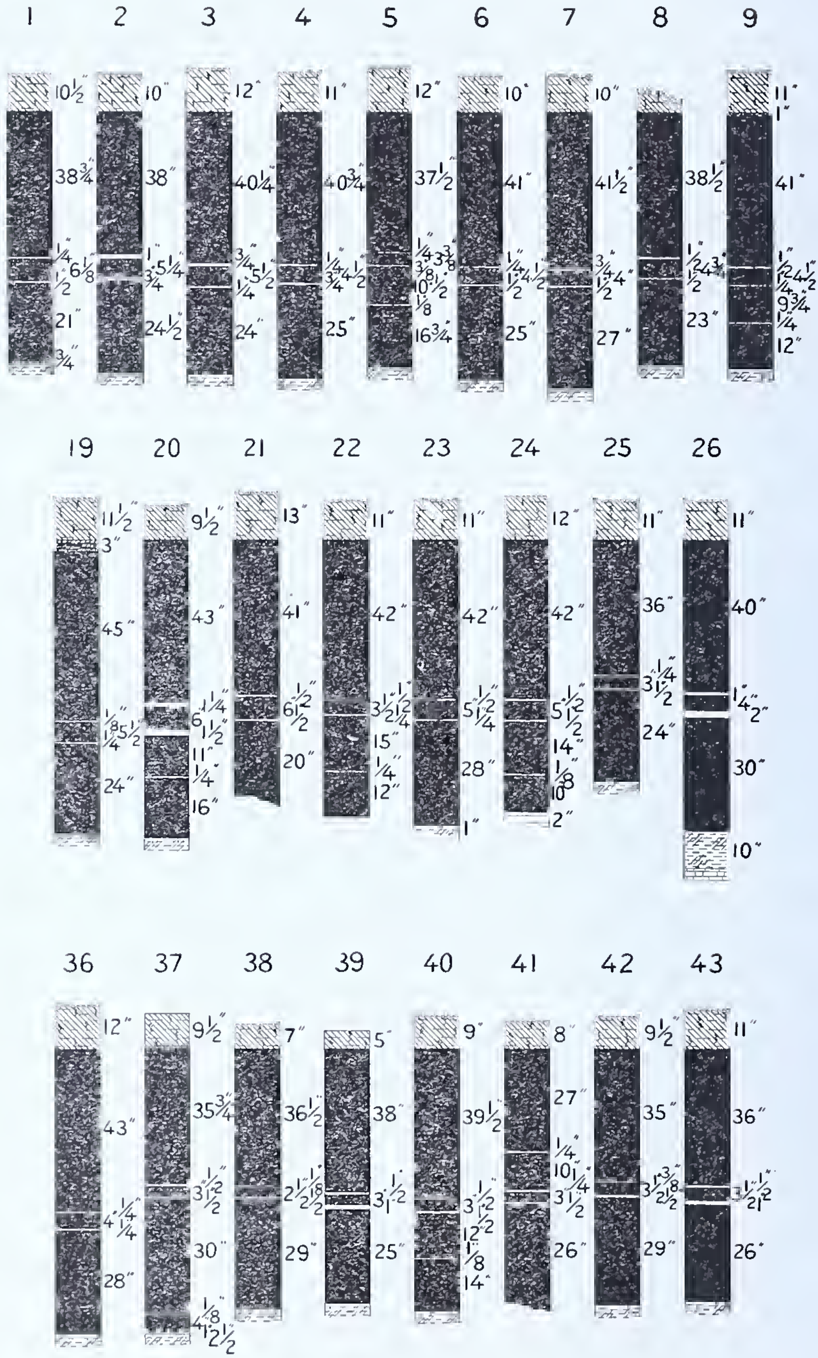


Figure 17. Sections of Pittsburgh coal bed.

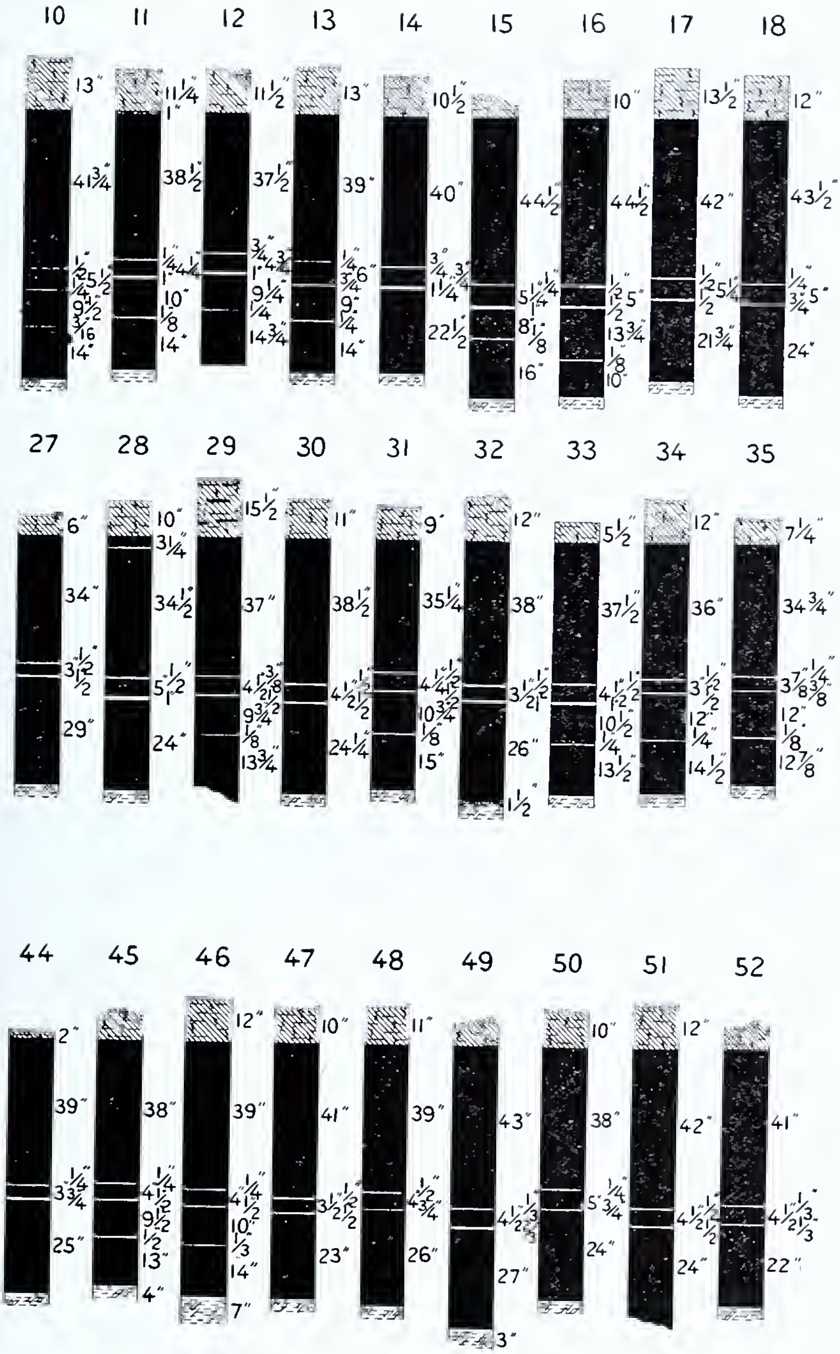


Figure 18. Sections of Pittsburgh coal bed.

37. Abandoned entry to Montour No. 10 mine, Pittsburgh Coal Company, 300 yards south of B. M. 994, Catfish Run, Snowden township.

38. Country bank, abandoned, ¾ mile N-NW. of Snowden, Snowden township.

39. Country bank, abandoned, ½ mile north of Gastonville, Union township.

40. Country bank, south side Peters Creek Valley, 1 mile NE. of B. M. 1004.

41. Country bank, abandoned, ¾ mile SW. of Walton Station, Jefferson twp.

42. Blaine mine, Diamond Coal & Coke Company, 1¼ miles SW. of Elizabeth.

43. Patterson No. 2 mine, Hillman Coal & Coke Company, ¾ mile E. NE. of Elizabeth.

44. Country bank, ½ mile NE. of B. M. 1148, near West Elizabeth, Jefferson township.

45. Dorsey Brothers country bank ½ mile west of Coal Valley, Jefferson twp.

46. Edmundson mine, Bowman Brothers Coal Company, 2/3 mile W-NW. of B. M. 911, near Portvue, Portvue township.

47. Marmie and Carothers country bank, ½ mile SE. of B. M. 1121, on the Portvue-Elizabeth road, Lincoln township.

48. Robert Griffiths country bank, near B. M. 1030 in the upper part of Wiley Run Valley, Elizabeth township.

49. Country bank, abandoned, ¼ mile SE. of Alpsville station, Versailles twp.

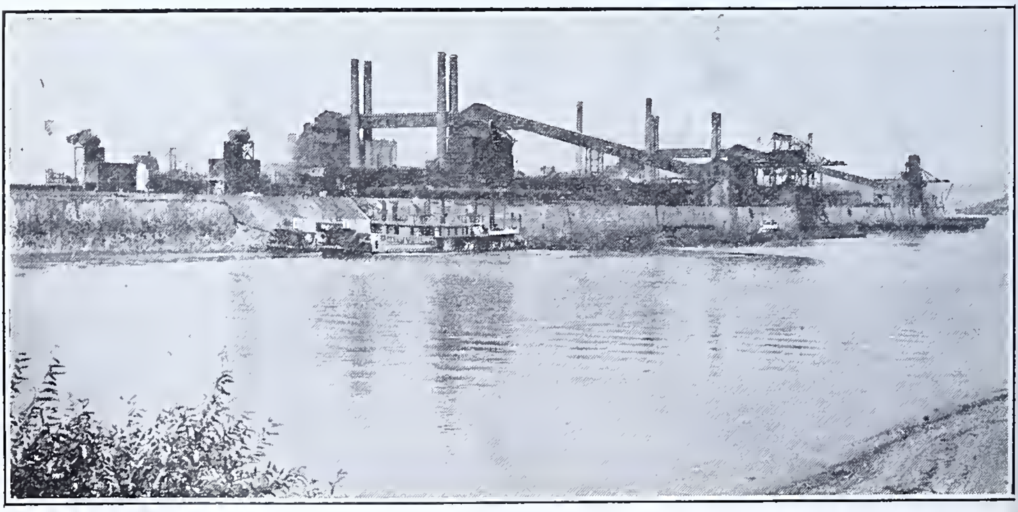
50. Shaner mine, Pittsburgh Coal Company, at Yohoghany, Sewickley township.

51. Country bank, abandoned, ½ mile NE. of Buenavista, Elizabeth township.

52. Ocean No. 1 mine, Pittsburgh Coal Company, Scott Haven, Sewickley twp.

Plate XVII

A. A Tow of 10,000 tons of coal on Monongahela River



B. By-product coke plant at Clairton.

TOPOGRAPHIC AND GEOLOGIC
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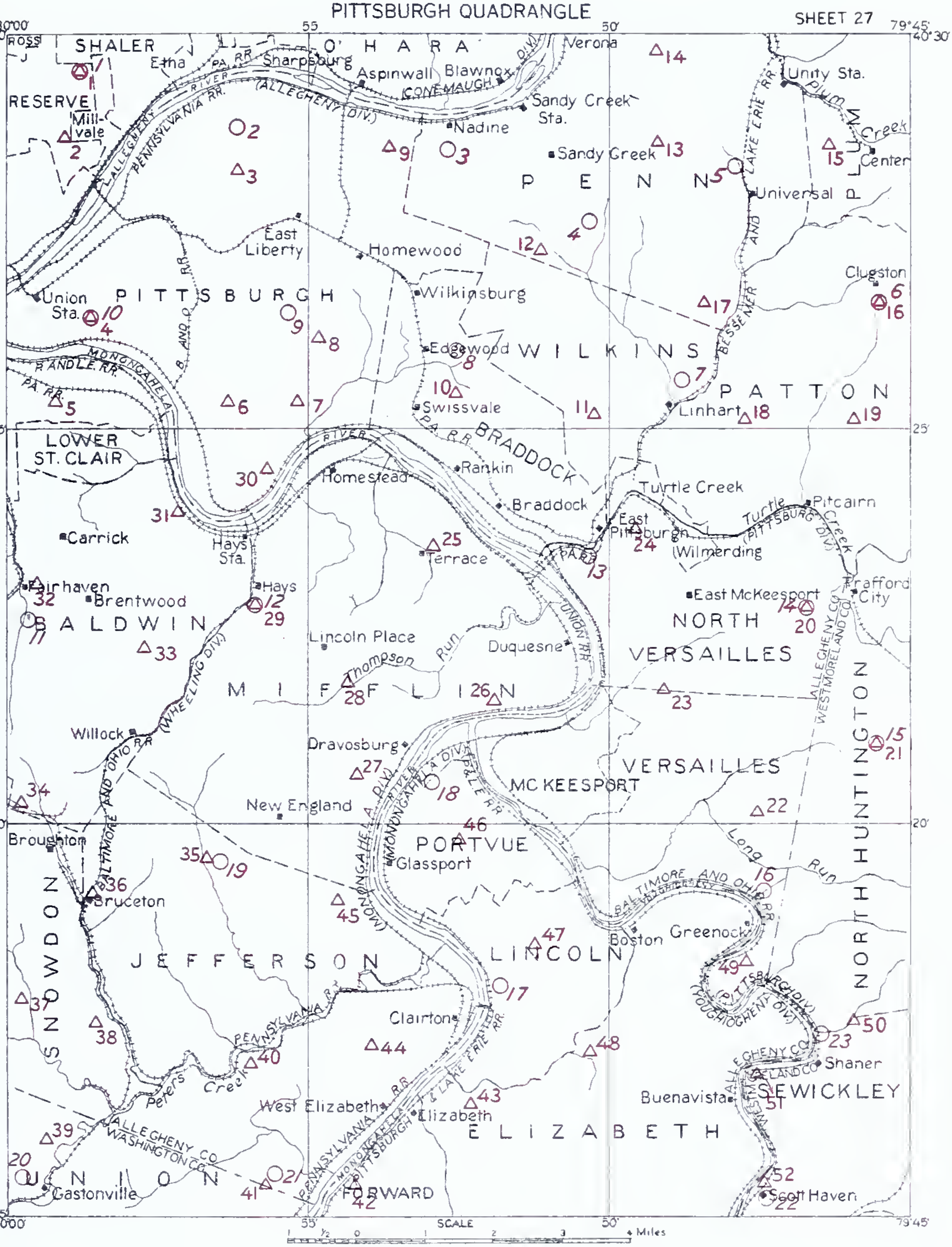
PITTSBURGH QUADRANGLE

SHEET 27



○ 26 = Roof coal section

△ 43 = Section of main bed

PLATE XVIII. LOCATION OF SECTIONS OF THE PITTSBURG COAL BED.

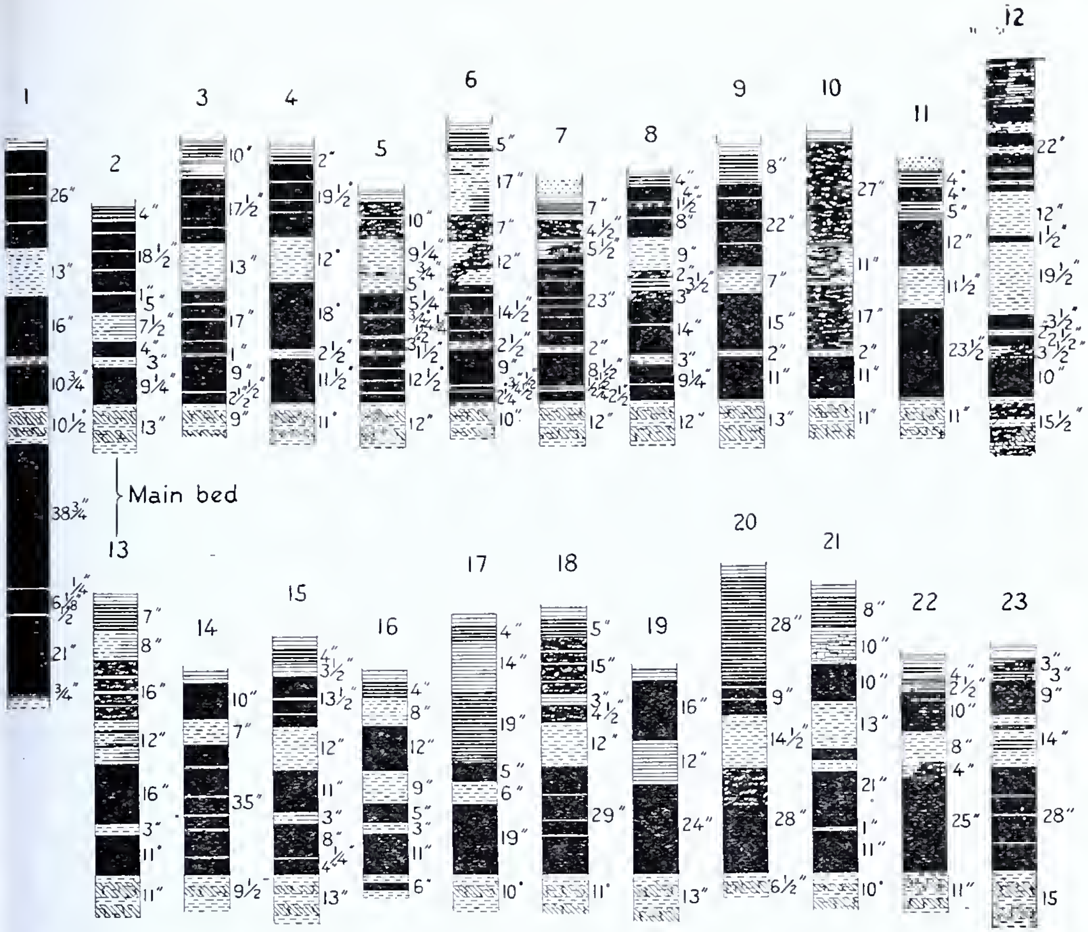


Figure 19. Sections of Pittsburgh roof coal.

1. Country bank, abandoned, ½ mile south of B. M. 804, north of Millvale.
2. Country bank, abandoned, 2/3 mile south of the south end of the Etna bridge.
3. Country bank, 2/5 mile south of Nadine, Penn township.
4. Small stripping operation, abandoned, ¼ mile east of B. M. 1198, south of Sandy Creek, Penn township.
5. Hershey country bank, 3/5 mile north-northwest of B. M. 1065 at Universal, Penn township.
6. Stripping operation, ¼ mile southeast of Clugston cross-roads Patton township.
7. Country bank, abandoned, 1/3 mile northeast of Linhart, Wilkins township.
8. Country bank, abandoned, ¼ mile northwest of B. M. 999 near Edgewood.
9. Outcrop near corner of Aylesboro Street and Murray Avenue, Squirrel Hill district, Pittsburgh.
10. Country bank above Booth and Flynn brick plant, ½ mile northwest of Brady Street bridge, Pittsburgh.
11. Air course to abandonded mine, ½ mile south of Fairhaven, Baldwin township.
12. Smith mine, abandoned, Hays Gas Coal Co., ¼ mile south of Hays, Baldwin & Mifflin townships.
13. Country bank, abandoned, 2/3 mile east of the mouth of Turtle Creek.
14. Spring Hill mine (stripping operation), Export Coal Co., top of hill west of Trafford City.
15. Country bank, 1 2/3 miles south of Brush Creek and about 2½ miles south of Trafford City.
16. Country bank, abandoned, ¼ mile west of Emblem, Versailles township.
17. Belle Bridge mine, W. E. Carothers, ¼ mile SE of Belle Bridge Station, Lincoln township.
18. Country bank, ½ mile northeast of Otto, Portvue township.
19. Montour No. 8 mine, Pittsburgh Coal Co., in valley of Lewis Run, 2 miles east of Bruceton, Jefferson township.
20. Henderson No. 2 mine, Henderson Coal Co., 1/3 mile west of Gastonville, Union township.
21. Country bank, abandoned, near El Rama crossroads, ½ mile southwest of Walton, Jefferson township.
22. Country bank, abandoned, Scott Haven, Sewickley township.
23. Country bank, Guffey Station, Sewickley township.

Analyses of coal samples from widely separated mines prove that the uniformity characteristic of this bed applies to its chemical as well as its physical properties.

Analyses of Pittsburgh coal

(H. M. Cooper, U. S. Bureau of Mines, analyst)

Mine, locality and sample number	Proximate, as received		Ultimate, as received		Calorific value	
					Calories	B.t.u's.
Smith wagon mine, at end of Lincoln car line, ¾ mile SW. of Nadine. Composite No. 85,818	Moisture Vol. matter Fixed carbon Ash	4.0 34.6 55.3 6.1	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.1 5.6 74.9 1.6 10.7	7,411	13,340
Moramina wagon mine, ¾ mile south of Universal Composite No. 85,901	Moisture Vol. matter Fixed carbon Ash	3.0 34.9 54.7 7.4	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.1 5.3 75.5 1.0 9.7	7,494	13,490
Herald and Bowers wagon mine, ½ mile S. E. of B. M. 1202 Monroeville Composite No. 82,223	Moisture Vol. matter Fixed carbon Ash	2.9 34.9 54.8 7.3	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.2 5.4 75.4 1.4 9.3	7,511	13,520
Kochler wagon mine, ½ mile S. E. of Lincoln Place Composite No. 85,962	Moisture Vol. matter Fixed carbon Ash	3.9 34.1 56.0 6.0	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.4 5.5 75.6 1.4 10.1	7,506	13,510
Bertha mine, Bruceton. Sample No. 2,080	Moisture Vol. matter Fixed carbon Ash	3.7 34.0 56.8 5.5	Sulphur	1.4	7,706	13,870
Experimental mine, ½ mile N. W. of Wallace Composite No. 11,986	Moisture Vol. matter Fixed carbon Ash	2.7 36.0 55.0 6.3	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.4 5.3 76.8 1.5 8.7	7,678	13,820
Patterson No. 2 mine, ⅔ mile S. E. of mouth of Wiley Run, Elizabeth township Sample No. 20,034	Moisture Vol. matter Fixed carbon Ash	2.5 33.9 57.2 6.4	Sulphur Hydrogen Nitrogen Nitrogen Oxygen	0.8 5.3 78.1 1.6 7.8	7,644	13,760
Ocean No. 2 mine, across river from Scott Haven, Sewickley township Sample No. 6,627	Moisture Vol. matter Fixed carbon Ash	2.6 32.7 59.4 5.3	Sulphur Hydrogen Carbon Nitrogen Oxygen	0.8 5.4 78.2 1.5 8.8	7,828	14,090
Union Valley No. 2 mine, ½ mile north of Emblem, Versailles township Composite No. 82,398	Moisture Vol. matter Fixed carbon Ash	3.2 32.8 56.5 7.5	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.4 5.3 75.1 1.5 9.2	7,494	13,490

Before mining operations were begun there were in this quadrangle 680,988,000 tons of Pittsburgh coal, divided among the townships and the city of Pittsburgh as follows:

Original tonnage of Pittsburgh coal in the Pittsburgh quadrangle

Township or other area	Area of coal Square miles	Short tons
City of Pittsburgh	3.71	24,892,000
Penn township	6.10	42,006,000
Plum township	1.01	7,348,000
Patton township	4.29	30,026,000
Wilkins township and Wilkinsburg	4.20	27,917,000
Reserve township	.17	1,136,000
North Versailles township	3.52	26,122,000
North Huntingdon township	6.60	46,702,000
Versailles township including McKeesport	.80	5,900,000
Lincoln township	2.40	15,728,000
Portvue township, including West McKeesport	1.70	11,213,000
Braddock township, including East Pittsburgh, Braddock, N. Braddock, Rankin and Swissvale	1.60	10,554,000
Baldwin township, including Knoxville, Mt. Oliver and Carick	12.15	77,990,000
Mifflin township	13.65	79,956,000
Jefferson township	13.58	92,932,000
Snowden township	3.98	28,981,000
Union township	4.02	26,126,000
Forward township	1.18	7,898,000
Elizabeth township	11.65	78,961,000
Sewickley township	5.84	38,800,000
Totals	102.15	680,988,000

Of the above total tonnage, it is estimated that almost exactly 75 per cent, or 510,741,000 tons have been mined or irretrievably lost. Assuming that 95 per cent of the remaining coal is recoverable, and that of that amount 15 per cent will be lost in mining operations, there will eventually be recovered 95 per cent x 85 per cent x 170,247,000 tons or 137,474,450 tons. Since yearly production will probably tend to diminish on the average, and since in the past this coal has been mined at a yearly rate of about 3,500,000 tons, it is probable that there will still be recoverable Pittsburgh coal in this quadrangle 25 years from now.

Bakerstown Coal.

This coal is not really of workable thickness in this quadrangle, but it becomes so just north of the quadrangle boundary, north of Millvale. The sections shown in Figure 20 illustrate its character. Even in its type locality the coal is high in ash, as shown by the following analysis of a sample taken at a mine about 10 miles north of the quadrangle boundary and only a mile south of Bakerstown.

Analysis of Bakerstown coal
(H. M. Cooper, U. S. Bureau of Mines, analyst)

Mine, locality and sample number	Proximate, as received		Ultimate, as received		Calorific value	
					Calories	B.t.u's.
Fisher mine, 1 mile south of Bakerstown. Upper bench of coal. Sample No. 83,120	Moisture	2.2	Sulphur	3.4	6,256	11,260
	Vol. matter	34.1				
	Fixed carbon	42.5				
	Ash	21.2				

Coal of this character is fit only for local, domestic use.

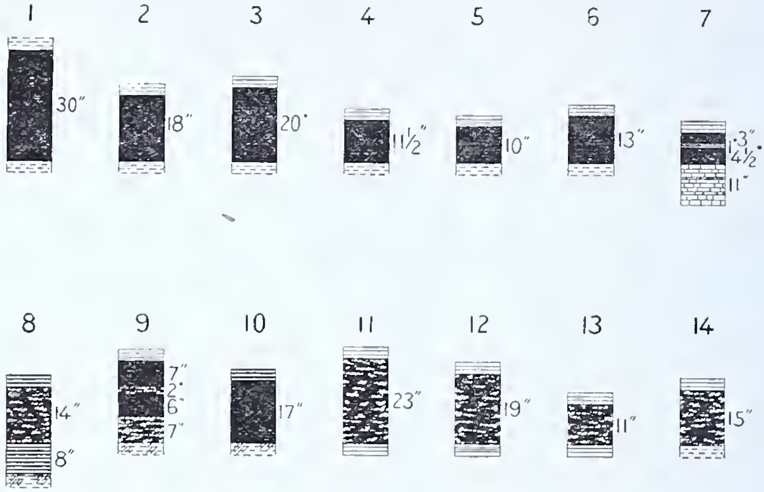


Figure 20. Sections of Bakerstown coal.

1. Country bank, abandoned, ¾ mile W-NW. of B. M. 804, north of Millvale.
2. Prospect entry, ¼ mile SW. of B. M. 804, north of Millvale.
3. Outcrop, ½ mile SW. of B. M. 804, north of Millvale.
4. Outcrop, 1/3 mile SE. of B. M. 804, north of Millvale.
5. Outcrop in river bluff at Etna, ¾ mile east of B. M. 839.
6. Outcrop, valley ¼ mile east of Squaw Run, O'Hara township.
7. Outcrop along trolley track, ½ mile SE. of Verona.
8. Diamond drill-hole, ¼ mile north of B. M. 1194, southeast of Verona.
9. Diamond drill-hole, 1/3 mile NE. of B. M. 929 at Unity Station.
10. Diamond drill-hole, 2/5 mile NW. of B. M. 1022 on Bessemer & Lake Erie Railroad, southwest of Unity Station.
11. Diamond drill-hole, ½ mile S-SE. of B. M. 1107 at Universal.
12. Diamond drill-hole, ½ mile north of B. M. 1171 near Monroeville.
13. Diamond drill-hole, one mile W-SW. of Hays Station.
14. Outcrop, ¼ mile SW. of the mouth of Ninemile Run, between Swissvale and Squirrel Hill.

Upper Freeport coal.

The development of the Upper Freeport coal bed, the "thick Freeport" of northern Allegheny county, has only just begun in this quadrangle. The No. 1 mine of the New Field By-Products Coal Company, located just north of the quadrangle boundary near North Bessemer, and the Hubbard mine of the McKeesport Coal & Coke Company, at Versailles, have been operating since 1916 and 1924 respectively; but as shown in Plate XIX the Upper Freeport underlies large areas far beyond the limits of these two mines. A shaft on the north bank of Monongahela River, east of Braddock, is reputed to have been sunk to the Upper Freeport coal many years ago; but information concerning the operation is lacking. All the data available from diamond drill-holes and churn drill-holes were used in the preparation of Plate XIX but in spite of the large number of records used, there are certain areas where the thickness of the coal is still in doubt. In such areas the limiting line of the thick coal is shown by a dashed line rather than the full line used elsewhere.

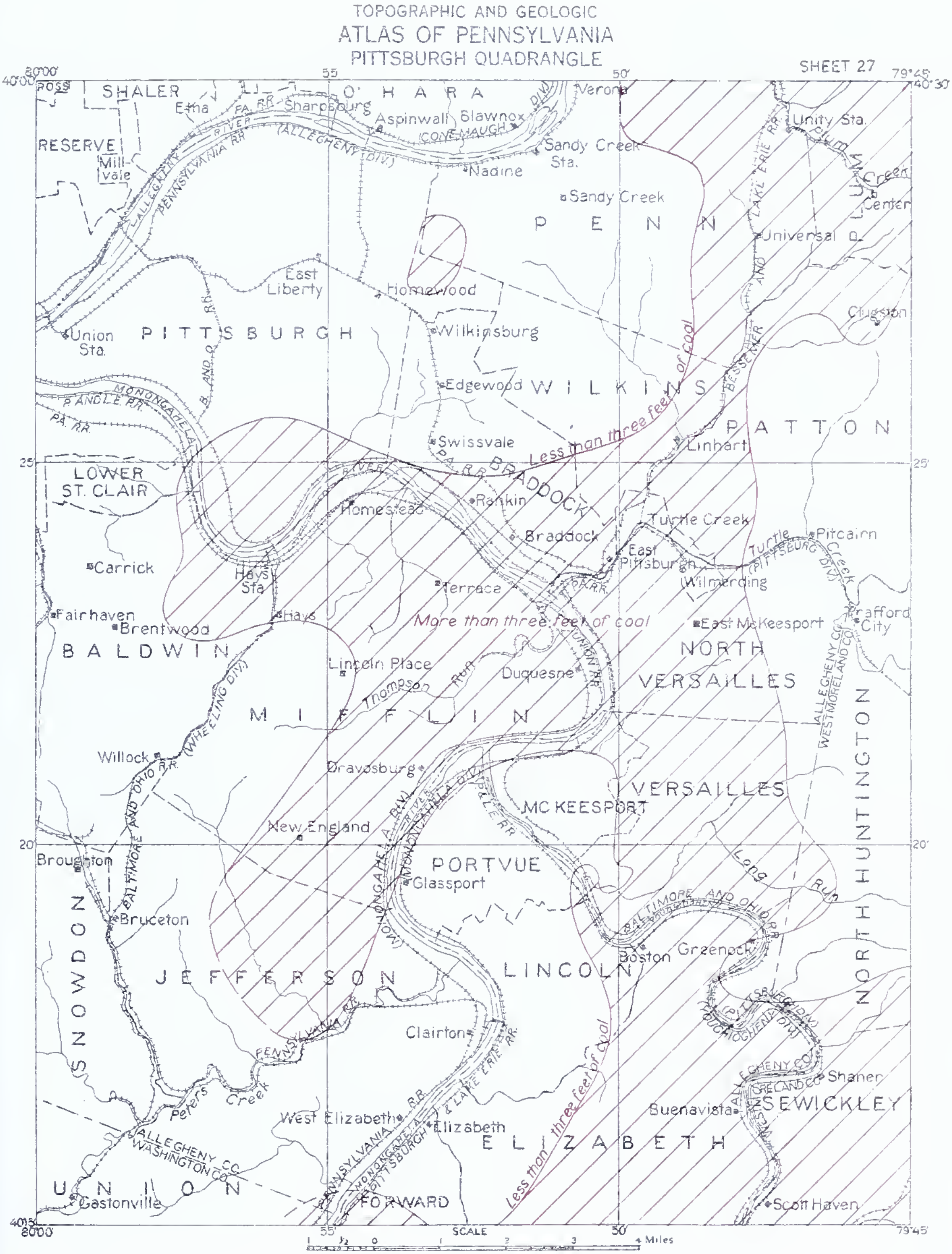


PLATE XIX. AREA UNDERLAIN BY UPPER FREEPORT COAL MORE THAN THREE FEET THICK.

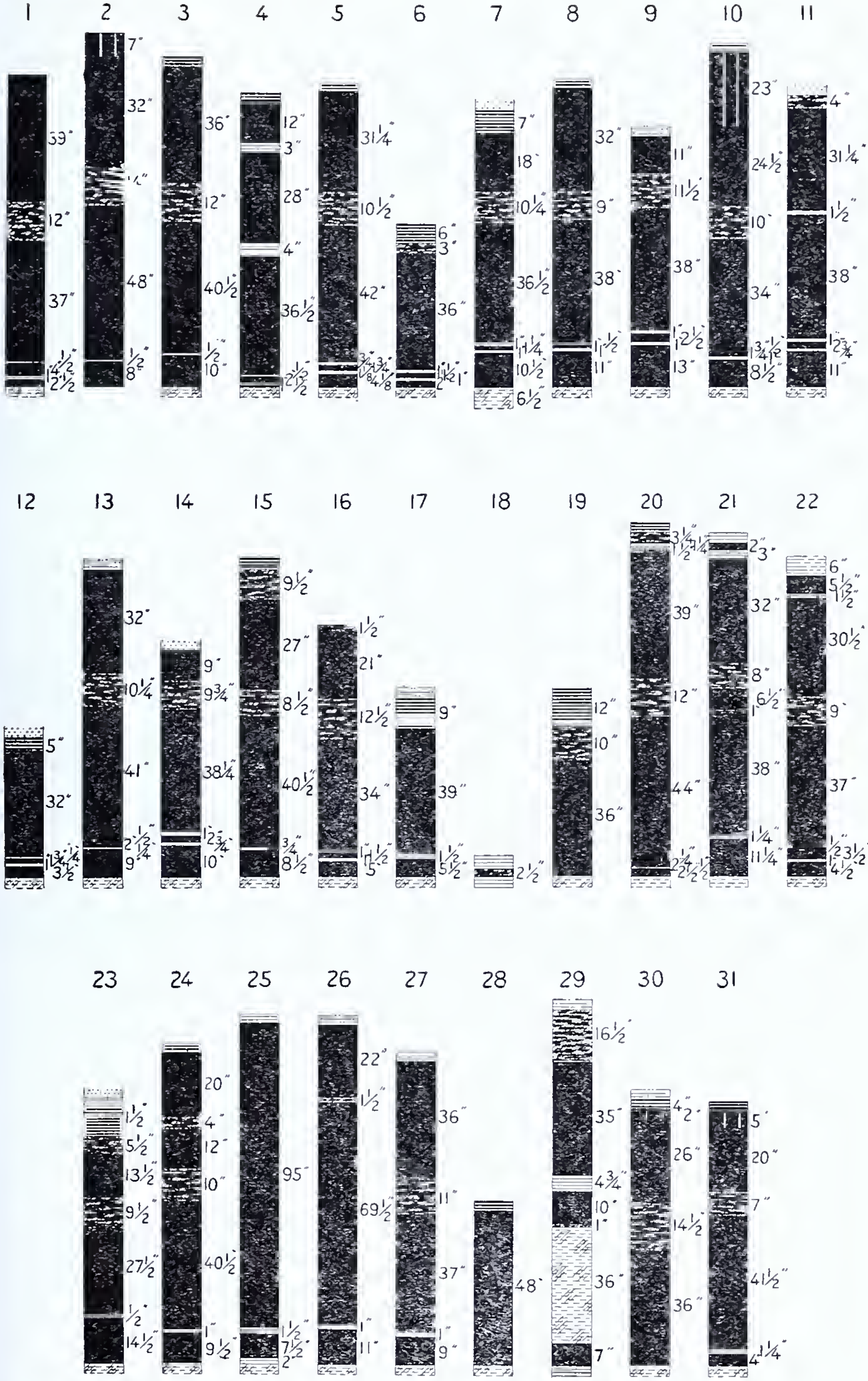


Figure 21. Sections of Upper Freeport coal

Figure 21. Sections of Upper Freeport coal.

1. No. 1 mine, Newfield By-Products Coal Company, ½ mile NW. of North Bessemer. Section at face of two right entry south of left entry.
2. Same. On rib one east entry 150 feet from face.
3. Diamond drill-hole, Catz farm, ⅓ mile NE. of Unity Station.
4. Diamond drill-hole, Wilson Davidson farm, 2 miles NW. of Unity Station.
5. Diamond drill-hole, John Pahlman Heirs farm, 1 mile SW. of Unity Station.
6. Diamond drill-hole, Joe Stotler farm, 1 mile west of B. M. 1107 at Universal.
7. Diamond drill hole, A. A. Miller property, at Center.
8. Diamond drill-hole, Johnson farm, ½ mile east of Center.
9. Diamond drill-hole, William Pickford farm, ¾ mile south of Center.
10. Diamond drill-hole Robert Reiter farm, 1 mile W-SW. of Center.
11. Diamond drill-hole, Robert Reiter farm, ¾ mile east of B. M. 1107 at Universal.
12. Diamond drill-hole, Telford farm, ⅔ mile SE. of B. M. 1065, at Universal.
13. Diamond drill-hole, Carothers heirs farm, 1 3/10 miles E-SE. of B. M. 1107, at Universal.
14. Diamond drill hole, Carothers Heirs farm, ½ mile NE. of B. M. 1196, near Clugston.
15. Diamond drill-hole, William Beatty farm, ½ mile NW. of B. M. 1196, near Clugston.
16. Diamond drill-hole, James and John Fry, farm ½ mile north of the junction of Lake and Thompson runs.
17. Diamond drill-hole, William Shaw farm, ⅙ mile west of B. M. 1149, at Clugston.
18. Diamond drill-hole, Carothers farm, ½ mile north of B. M. 1171, near Monroeville.
19. Diamond drill-hole, Westinghouse Electric & Manufacturing Company, near Pitcairn Street, Wilmerding, and 1,000 feet west of the Wilmerding station.
20. Diamond drill-hole, James H. Moore, farm ¾ mile south of the sharp bend in the railroad at Turtle Creek borough.
21. Diamond drill-hole, James White farm, ⅓ mile west of B. M. 1226, near East McKeesport.
22. Diamond drill-hole, Bowman farm, nine-tenths of a mile south of B. M. 1226, near East McKeesport.
23. Diamond drill-hole, Wilmerding Land Company farm, ½ mile SE. of B. M. 1057, in the southwest part of North Versailles township.
24. Diamond drill-hole, about 150 feet SE. of Bessemer station (Port Perry), at the junction of Turtle Creek and Monongahela River.
25. Diamond drill-hole, Hays Estate, ⅖ mile S-SE. of B. M. 1081, near Terrace.
26. Diamond drill-hole, Hays Estate, ¼ mile NW. of B. M. 1081, near Terrace.
27. Hubbard mine, McKeesport Coal & Coke Company, Versailles borough. Section 2500 feet east of shaft.
28. Diamond drill-hole, 175 yards E-SE. of B. M. 793, near Boston.
29. Diamond drill-hole at Rillton, Sewickley township.
30. Diamond drill-hole, ¼ mile south of Lock No. 3 on Monongahela River.
31. Diamond drill-hole, 1 mile south of Lock No. 3, Monongahela River.

Knowing the prevalence of sandstone horsebacks in the Upper Freeport it is certain that not all of the area outlined is underlain by coal of workable thickness, but the coal has been found in enough drill-holes to make it equally certain that by far the larger part of that area is underlain by fine coal, three feet or more thick. It is quite possible also that in addition to the area shown, there are other areas of workable coal not as yet discovered by drilling.

As seen in the cores from diamond drill-holes and in the Hubbard mine, the coal is bright, blocky, and hard. Where thick it is usually divided into an upper and lower bench by 7 to 15 inches of bony coal. Frequently it is also characterized by a double split near its base, the shale or clay partings usually being less than an inch thick. A less frequently observed characteristic is a layer of cannel coal at the top of the upper bench. Figure 21 would seem to indicate very clearly that the lower bench of the coal is more persistent than the upper, and that the "thick" Freeport is limited to the area in which the upper bench occurs.

As shown in the sections the Upper Freeport is nearly always underlain by clay. It is overlain by clay-shale, shale or sandstone. Where the latter rock forms the roof it usually cuts into the coal and in some places completely replaces it. Though the sandstone is universally spoken of as cutting into the coal, actually it cannot be held responsible for the disappearance of the coal; that was eroded before the sandstone was deposited. These sandstone "horses" are a very undesirable feature of mining operations in the Upper Freeport bed. Clay veins and slack veins are much less common and not a serious hindrance.

The core from Hole No. 1 on the Robert Reiter farm (see section No. 10) was divided[1] as follows and analyzed.

Section of Upper Freeport coal on Robert Reiter farm.

	Ft.	in.
Cannel coal	1	10¼
Coal (A)	2	0
Bony Coal (B)	0	9½
Coal } (C)	2	10½
Bony } (C)	0	2¼
Coal } (C)	0	8½

Analyses of Upper Freeport coal.
(Pittsburgh Testing Laboratories, analyst)

	A	B	C	(5 ft. 7 in.) A & C
Moisture	.34		.34	.50
Volatile matter	31.55	22.45	30.40	32.03
Fixed carbon	57.96	43.21	64.84	61.15
Ash	10.15	33.57	4.42	6.32
Sulphur	2.70	.38	.60	1.42
Phosphorus	.007		.007	.007
B. t. u's.	13,625	9,891	14,591	14,312

[1]Measurements, division for analysis, and sampling done by Richard L. Smith.

The above analyses show that in the vicinity of Center the lower bench of Upper Freeport coal is remarkably free of impurities, that the upper bench is fairly good coal, and that a mixture of the two compares well with Pittsburgh coal. Even the bony coal separating the upper and lower benches could be satisfactorily burned in a powdered condition.

Analyses of samples taken from mines operating in the Upper Freeport show that the above statements apply to the coal in other localities as well.

Analyses of Upper Freeport coal.

(H. M. Cooper, U. S. Bureau of Mines, analyst)

Mine, locality and sample number	Proximate, as received		Ultimate, as received		Calorific value	
					Calories	B.t.u's.
No. 1 mine, New Field By-Products Coal Co., ½ mile north of North Bessemer. Upper bench. Sample No. 32,256	Moisture Vol. matter Fixed carbon Ash	2.6 35.9 52.8 8.8	Sulphur	1.7	7,539	13,570
Same. Bony coal. Sample No. 32,260	Moisture Vol. matter Fixed carbon Ash	1.6 28.8 40.9 28.6	Sulphur	1.8	5,767	10,380
Same. Lower bench Sample No. 32,255	Moisture Vol. matter Fixed carbon Ash	4.9 32.2 57.0 5.9	Sulphur	0.5	7,806	14,050
Same. Composite of upper and lower benches. Sample No. 32,257	Moisture Vol. matter Fixed carbon Ash	3.7 33.9 55.1 7.4	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.1 5.3 76.1 1.5 8.6	7,522	13,540
W. H. Porter wagon mine, Glenshaw, 3½ miles north of Millvale. Sample No. 83,124	Moisture Vol. matter Fixed carbon Ash	2.4 36.5 53.8 7.2	Sulphur	2.3	7,539	13,570
Harmar mine, Harmarville, 2½ miles north of Verona. Sample No. 83,123	Moisture Vol. matter Fixed carbon Ash	2.4 33.8 55.8 8.0	Sulphur	1.5	7,567	13,620
Westmoreland Brick Co. mine, ½ mile southwest of Hunkers and 8 miles S-SE. of Cowansburg Composite No. 85,340	Moisture Vol. matter Fixed carbon Ash	2.7 34.8 54.6 7.9	Sulphur Hydrogen Carbon Nitrogen Oxygen	3.6 5.3 75.2 1.3 6.7	7,628	13,730

It is estimated that within the are outlined in Plate XIX there were originally 569,017,000 tons of Upper Freeport coal, divided among the townships and the city of Pittsburgh as follows:

Original area and tonnage of Upper Freeport coal in the Pittsburgh quadrangle, including only that area where the coal is three feet or more thick.

Township or other area	Area of coal Square miles	Short tons
City of Pittsburgh	4.02	15,541,000
Penn township	8.03	51,320,000
Plum township	4.61	37,250,000
Patton township	4.99	35,232,000
Wilkins township and Wilkinsburg	2.11	14,249,000
North Versailles township	6.54	46,070,000
North Huntingdon township	1.93	10,520,000
Versailles township including McKeesport	9.31	61,457,000
Lincoln township	1.11	5,168,000
Portvue township, including West McKeesport	.43	1,734,000
Braddock township including East Pittsburgh, Braddock, North Braddock, Rankin and Swissvale	4.15	30,603,000
Baldwin township including Knoxville, Mt. Oliver and Carrick	2.50	10,348,000
Mifflin township	19.43	113,433,000
Jefferson township	5.06	34,086,000
Union township	.20	1,242,000
Forward township	.43	2,669,000
Elizabeth township	13.10	63,932,000
Sewickley township	6.25	34,163,000
Totals	94.20	569,017,000

Total production of Upper Freeport coal in this quadrangle to date (1926) is estimated to have been about 665,000 tons. Of this amount the McKeesport Coal & Coke Company has mined 212,724 tons and the New Field By-Products Coal Company the remainder. Comparing the tonnage mined with the estimated original tonnage, it is evident that the reserve of Upper Freeport coal has hardly been tapped as yet.

Kittanning coals.

The Upper Kittanning coal is believed to be too thin to warrant mining in any part of the quadrangle. In seven diamond drill-holes, sunk below the depth of this coal, one encountered 16 inches of coal, one 13 inches, and the others one foot or less. The Upper Kittanning is scarcely ever noted in churn drill-holes.

The Middle Kittanning coal, on account of its uniform thickness and wide extent, is a coal reserve second only to the Upper Freeport in importance. Occurring several hundred feet below the surface, its present value is low, owing to the presence of more easily accessible coals in this and nearby regions. But when the Pittsburgh coal bed is exhausted and the Upper Freeport thoroughly developed, then attention will be focused on the Middle Kittanning and it will be mined by shafts which will not have to be any deeper than several already sunk to the Pittsburgh coal in neighboring districts.

Figure 22. Sections of Kittanning coals.

Sections of Middle Kittanning coal.

1. Diamond drill-hole, mouth of Becks Run.
2. Diamond drill-hole, 1⅛ miles S-SW. of the mouth of Becks Run.
3. Diamond drill-hole, two miles west of Hays.
4. Diamond drill-hole, Hays estate, ½ mile S-SE. of B. M. 1081, near Terrace.
5. Diamond drill-hole at Greenock, Elizabeth township.
6. Diamond drill-hole at Rillton, Sewickley township, about two miles east of Yohoghany.

Sections of Lower Kittanning coal.

1. Diamond drill-hole at B. M. 790, Streets Run, between Baldwin and Mifflin townships.
2. Diamond drill-hole at Greenock, Elizabeth township.
3. Diamond drill-hole at Rillton, Sewickley township, about two miles east of Yohoghany.

At Rillton, approximately two miles east of Yohoghany, Sewickley township, the Middle Kittanning is 43 inches thick and 147 feet below the Upper Freeport. At Greenock it is 50 inches thick and 161 feet below the Upper Freeport. It was noted in several churn drill-holes in Sewickley township and seems to be fairly persistent in both Versailles and North Versailles townships and in the north part, at least, of North Huntingdon township, where it occurs at an average interval

of 160 feet below the Upper Freeport and about 800 feet below the Pittsburgh coal. In the churn drill-hole records the coal is stated to be 2 to 10 feet thick. Actually, however, it probably is nowhere more than five feet thick.

In Mifflin and Baldwin townships the coal was noted in a number of holes at intervals of 160 to 171 feet below the Upper Freeport, the interval decreasing from east to west. As recorded in diamond drill-holes the coal is 31 to 48 inches thick in most of this area. One hole, however, located half a mile southwest of Hays, failed to encounter any Middle Kittanning coal, its place being filled by Kittanning sandstone which is there unusually thick.

No data are available concerning the Middle Kittanning and lower coals in the district north of Allegheny River. In the southwest part of the quadrangle the Middle Kittanning has been noted in several churn drill-holes but is probably of mineable thickness in only a part of that area.

The Lower Kittanning coal, occurring usually about 40 feet below the Middle Kittanning, is apparently less persistent than the latter and somewhat thinner. It nevertheless constitutes a valuable reserve which will some day be mined. Its present value, in view of the fact that other, more available coal beds will probably supply the demand for at least 50 and more likely 100 years, is very low. Only three diamond drill-holes are known to have penetrated the horizon of this coal in or near this quadrangle. The one at Rillton went through 34 inches of coal at only 35 feet (top of Lower Kittanning) below the Middle Kittanning. At Greenock the interval is 39½ feet, but the coal is only 18 inches thick. The third hole, located half a mile southwest of Hays, found 44 inches of coal at a depth of 211 feet below the Upper Freeport. The coal has also been recorded in a number of churn drill-holes in the east half of the quadrangle, and in 10 or 11 holes in the northwest section.

The following quotation, taken from the second edition of Taylor's[19] "Statistics of Coal," is interesting but of very doubtful scientific value.

"Besides the main bed of workable coal at Pittsburgh,........ there is another seam of less value, on account of the intermixture of slate that it contains. These are considerably above water level. It has been ascertained, during the process of boring for salt water, in the vicinity of Pittsburgh, on the opposite side of the Monongahela river, that four good seams, besides two small ones, lie at a considerable depth below the surface .... The four coal beds were each about three feet and a half in thickness, and were reached at the respective depths of two hundred and eighty, four

[19]Taylor, R. C., Statistics of coal, second edition, pp. 334-335, 1855.

hundred and forty, four hundred and eighty, and five hundred and eighty feet."

No data are available concerning the physical and chemical characteristics of the Kittanning coals in this area, but there is no reason to believe that they are not as good here as in neighboring regions where they are being worked. A few analyses are given for purposes of comparison with other coals.

Analyses of Kittanning coals.

(H. M. Cooper, U. S. Bureau of Mines, analyst).

Mine, locality and sample number	Proximate, as received		Ultimate, as received		Calorific value	
					Calories	B.t.u's.
Robin Hood mine, ¼ mi. north of Cannelton Sta., Beaver County. Middle Kittanning coal. Composite No. 34,659	Moisture Vol. matter Fixed carbon Ash	5.4 34.9 54.8 4.9	Sulphur Hydrogen Carbon Nitrogen Oxygen	1.1 5.6 75.1 1.5 11.8	7,394	13,310
North Pittsburgh Realty Co. mine, Harmony Jct., Butler County. Middle Kittanning coal. Sample No. 25,615	Moisture Vol. matter Fixed carbon Ash	5.8 37.9 45.6 10.7	Sulphur Hydrogen Carbon Nitrogen Oxygen	4.3 5.7 68.6 1.2 9.5	6,917	12,450
Montgomeryville mine, Montgomeryville, Armstrong County. Middle Kittanning coal. Composite No. 28,776	Moisture Vol. matter Fixed carbon Ash	1.8 32.8 37.2 28.2	Sulphur Hydrogen Carbon Nitrogen Oxygen	3.7 4.5 56.9 1.1 5.6	5,811	10,460
Johnetta shaft mine, Johnetta, Armstrong County. Lower Kittanning coal Composite No. 83,598	Moisture Vol. matter Fixed carbon Ash	2.4 36.7 52.5 8.4	Sulphur Hydrogen Carbon Nitrogen Oxygen	2.7 5.3 75.1 1.4 7.1	7,528	13,550
Apollo No. 2 mine, near Salina, Westmoreland County. Lower Kittanning coal Composite No. 85,679	Moisture Vol. matter Fixed carbon Ash	2.7 35.8 53.8 7.7	Sulphur Hydrogen Carbon Nitrogen Oxygen	2.6 5.4 75.8 1.3 7.2	7,628	13,730
Coffman mine, 1 mile east of Dunbar, Fayette County. Lower Kittanning coal Sample No. 81,495	Moisture Vol. matter Fixed carbon Ash	2.3 30.0 57.6 10.1	Sulphur	4.3	7,411	13,340

Mines.

Many of the large mines formerly operated in this quadrangle have been worked out and abandoned. The following partial list of mines operating in the quadrangle in 1884 is taken from a report on the "Monongahela River Mines", published by the Pennsylvania Second Geological Survey. It includes most of the larger mines then operating.

Coal mines operating in the Pittsburgh quadrangle in 1884.

Name of mine	Locality	Production (Bushels per day)
Bausman	South Side, Pittsburgh	12,000
Ormsby	South Side, Pittsburgh	13,000
American	South Side, Pittsburgh	8,000 to 9,000
Beeks Run	Beeks Run	12,000
Walton Pool No. 1	Northwest of Hays Sta.	16,500
Risher	Hays	10,500
Hays' Streets Run	Hays	15,000
Bellwood	South of Munhall	10,000
Greensprings	Between Munhall and Duquesne	11,000
Keystone	Between Port Perry and McKeesport	......
Stone's	Dravosburg	14,000
Amity	Dravosburg	15,000
Camden	Camden	14,600
Allequippa	Camden	16,000
Rock Run	Camden	8,000
Pine Run	Coal Valley	20,000
Blackburn	Coal Valley	13,000
Robbins & Jenkins	Opposite Wilson	10,000
Bellevue	Opposite Clairton	12,000
Lovedale	Near Elizabeth	10,000
Horner & Roberts	Wiley Run	14,000
West Elizabeth	West Elizabeth	......
Lower Walton	West Elizabeth	23,000
Harvey O'Neil	South of Elizabeth	1,500
Jones	Between W. Elizabeth and Floreffe	10,000
Upper Walton	Between W. Elizabeth and Floreffe	17,000
Hilldale	Near Floreffe	9,000
Peters Creek Mine No. 2	Mouth of Lick Run	......
Peters Creek Mine No. 1	Near Gastonville	1,500
Armstrong	Opposite Buenavista	......
Buenavista	Buenavista	200 tons
Shaner	Shaner	......
White Ball	Between Shaner and Guffey	......
Blythe	Guffey	......
Eagle Nest	Opposite Coutler	......
Alpsville	Alpsville	......
Osceola	Opposite Greenock	8,000
Cornell & Werling	Boston	16,000
James O'Neil	South of Boston	9,000
Penny	Portvue	12,000
	Total daily production =	367,400 bushels
	or	15,625 tons

Even at that time (1884) many large mines had been exhausted and abandoned, hence it is not surprising to find that the majority of the mines in operation today are small country banks. In the following list, note how few of the old mines are still being operated.

Commercial mines operating in the Pittsburgh coal in 1923.

Nane of mine	Company name	Location (nearest town or village)	Production (tons)
Black Hills	Black Hill Coal Co.	Fairhaven	11,258
Becks Run	Becks Run Coal Co.	Carrick	15,427
Scholar	Baldwin Coal Co.	"	9,102
Hill Top	Hill Top Coal Co.	Hays Sta.	12,000
Fishwick	Aerial Coal Co.	" "	28,000
Smith	Hays Gas Coal Co.	Hays	11,700
Risher No. 1	Homestead Coal Co.	"	7,039
Park	Park Coal Co.	"	17,827
Hays	West Run Coal Co.	"	6,142
United States	U. S. Coal & Supply Co.	Hazelwood	3,682
Morgan	Schenley Coal Co.	"	5,247
Burke	Marion Coal Co.	"	1,200
Thompson	R. L. Thompson	Bloomfield	3,000
River Hill	Wilmerding C. & S. Co.	Pittsburgh	7,842
Elek	John Elek	Terrace	10,591
Wacho	Joseph Wacho	"	3,555
Union Valley No. 1	Union Valley Coal Co.	Lincoln Place	112,871
Reed	McClure Coal Co.	" "	9,618
McClure	Bull Run Coal Co.	" "	9,590
Scott	Camden Coal Co.	Camden	17,164
Allequippa	Allequippa Coal Co.	"	9,500
Rock Run	Walters Coal Co.	New England	30,000
Bickerton	M. C. Bickerton	West Elizabeth	14,817
West Elizabeth	David Davis	" "	6,784
Iola	Hurd and Davis	Large	6,516
Mine No. 7	Pgh. Terminal C. Co.	"	114,950
Clyde	Evans Gas Coal Co.	Snowden	17,291
Piney Fork	Peters Cr. Gas Coal Co.	"	77,176
Gould	Bertha Con. Fuel Company	Wallace	220,882
Glenn	Liberty Coal Co.	"	13,621
Porter	Bruceton Fuel Co.	Bruceton	5,504
Bertha	Domestic Coal Co.	"	9,011
Mine No. 6	Pgh. Terminal Coal Co.	"	231,159
Montour No. 8	Pittsburgh Coal Co.	"	474,615
Mine No. 4	Pgh. Terminal C. Co.	"	507,100
Harper	Harper Coal Co.	East McKeesport	11,522
Taylor	T. H. & R. A. Taylor	East McKeesport	23,553
Carpenter	A. C. Overholt Coal Co.	" "	13,629
Semenko	John Semenko	" "	4,732
Hiland	Bowman Bros.	McKeesport	21,776
State Road No. 1	State Road Coal Co.	Emblem	72,066
Myers	H. J. Myers	"	31,070
Michael & Gordon	Robert Butler	"	3,600
Edmundson	Bowman Bros.	Portvue	2,456
Blackburn	R. B. Blackburn	Glassport	1,720
Green	Green Coal Co.	Glassport	17,069
McClure No. 2	Mon-Yough Coal Co.	Liberty Boro.	16,246
McClure No. 3	"	Belle Bridge	12,897
Marine & Carothers	M. & C. Coal Co.	" "	2,526
Belle Bridge	W. E. Carothers C. Co.	" "	15,533
Ella May	Farmer, Stentz & Molleston	" "	27,186
Pierce	Clyde W. Pierce	" "	8,252
Griffiths	Robert Griffiths	Elizabeth	13,301
Yough No. 2	Pittsburgh Coal Co.	Boston	67,378
Lincoln	Brendel Coal Co.	"	919
May	Boston Yough Coal Co.	"	22,744
Boyd	Boyd Coal Co.	"	5,600
Lovedale	Pittsburgh Coal Co.	Elizabeth	181,728
Patterson No. 2	Hillman Coal & Coke Co.	"	223,721
Neel	H. C. Neel	"	9,275
Blaine	Diamond Coal & Coke Co.	"	221,200
Spring Run*	Scott Haven Coal Co.	Scott Haven	16,559
Ocean No. 2	Pittsburgh Coal Co.	" "	296,257
Ocean No. 1	"	" "	15,307
Central Yough No. 1	Cen. Yough C. Co.	Shaner	18,664
Shaner	Pittsburgh Coal Co.	"	119,060

Nane of mine	Company name	Location (nearest town or village)	Production (tons)
Coulter	M. P. Clark	Alpsville	1,358
Decker	Boston Coal Co.	Greenock	5,171
Lincoln	Exton Coal Co.	Circleville	11,500
Taylor	Taylor Coal Co.	"	9,000
Weinman	Weinman Bros.	Wilkinsburg	14,536
Hampton	F. M. Lather	Wilkinsburg	1,800
Sarver	Hall Coal Co.	East Pittsburgh	20,176
Grimm	Grimm Coal Co.	Pitcairn	12,870
Bolton	Pitcairn Gas Coal Co.	Pitcairn	30,614
Yothers	C. B. Yothers	Monroeville	17,054
Harper No. 1	Harper Coal Co.	"	46,043
Hall	Hall Coal Co.	"	30,000
Miller	Miller Brothers	Linhart	28,800
York	York Estate	Wilkinsburg	5,522
Morrow	H. S. Morrow	Sandy Creek	10,000
Steele	John F. Steele	" "	1,550
Delmas	H. M. Cribbs	Universal	5,820
Plum Creek	Harper Coal Co.	Unity Station	17,422
Berg & McConnell	Berg & McConnell	" "	10,306
Stoner & Wilson	Stoner & Wilson	Sandy Creek	6,149
Roadside	H. M. Cribbs	Unity Station	21,856
Frazier	Frazier Bros.	" "	7,695
Peterman	John H. Peterman	" "	5,872
Henderson No. 2	Henderson Coal Co.	Gastonville	65,584
First Pool	First Pool Gas Coal Co.	Hays	18,785
Berline*	S. A. and S. Coal Co.	Floreffe	2,327

*Mining Redstone coal.

Total production of coal mines in 1923	3,947,117
Estimated production of coal from stripping operations	650,000
	4,597,117
Total daily production, assuming 300 working days in year	15,324

The production of mines operating in 1923 is given because the production since then has been greatly curtailed due to high labor costs and the low prices obtainable for coal, and hence later figures would not be representative. It is interesting to note that the daily production in 1923 was almost the same as in 1884.

NATURAL GAS.

For some unknown reason natural gas is seldom accorded its proper place in the list of our natural resources. For example, of the raw materials mined in Pennsylvania in 1923, coal ranks highest in point of value, and natural gas holds second place with a total value of $25,887,000 at the well. It has been one of the largest factors in the development of the great iron and steel industries of Pittsburgh, for this efficient fuel was for many years sold at such a price that the fuel cost of manufacturing was greatly lowered. The cost of living for residents in the Pittsburgh district was also lowered by the introduction of this fuel in place of coal, for although natural gas is now sold at a figure commensurate with its real value, at the time it was first piped into Pittsburgh, it literally sold for a song. The

following interesting lines,[1] dealing with the early history of the use of natural gas in Pittsburgh and written in 1886, are believed worthy of repetition.

"Since that time (1883), the depression of the coal mining industry in the Pittsburgh district, due to the general application of natural gas for domestic as well as industrial purposes has caused a curtailment of over 20 million tons in the yearly production (of coal). ....

At this date (1886) 3,000 families, 34 iron and steel mills, 60 glass factories, and 300 smaller factories and hotels are using for their fuel gas obtained and distributed through the pipes of this one company (Philadelphia Company), ... Already, it is claimed, there has been effected a saving of 40 per cent in the fuel cost of manufacturing."

Composition.

Natural gas is an odorless, tasteless, colorless fluid consisting of an intimate mixture of gaseous hydrocarbons. When burned with a sufficient amount of air it forms a transparent, blue flame giving a very hot fire and leaving no solid products of combustion. It is clean and easily handled. In short, it is the ideal fuel.

No analyses of gas from specific wells within this quadrangle are available, but other tests have shown that the dry gas from all parts of western Pennsylvania is essentially the same. The following analyses,[20] also indicate that gas from one sand is much the same as from another.

Analyses of natural gas from Murrysville and Elizabeth sands near Trafford City, Pa.

Constituents	Gas from Murrysville sand at 1,700 ft.	Gas from Elizabeth sand at 2,295 ft.
Carbon dioxide	Trace	Trace
Methane	98.8	94.0
Ethane		5.2
Nitrogen	1.2	.8
	100.0	100.0

The natural gas used in Pittsburgh comes from many hundreds of wells in Pennsylvania and others in West Virginia. Although new wells are constantly being turned into the lines and old ones taken out, the composition of the gas is almost constant; the gas from different wells evidently being very uniform.

[1] d'Invilliers, E. V., The Pittsburgh coal region, Pa. Second Geol. Survey, Ann. Rept. 1886, pt. I, pp. 18 and 19, 1887.

[20] Burrell, G. A., and Oberfell, G. G., Composition of the natural gas used in twenty-five cities: U. S. Bur. of Mines Tech. Paper 109, p. 9, 1915.

Composition of Pittsburgh natural gas[21]

Test No.	Date	CH_4	C_2H_6	N_2	B.t.u. per cu. ft. at 760 mm. and 60°F.	Sp. gr. calculated
1	12-7-12	80.8	18.5	0.7	1,140	0.65
2	4-7-13	80.4	18.9	.7	1,143	.65
3	4-21-13	80.7	18.5	.8	1,139	.65
4	5-9-13	78.7	20.4	.9	1,152	.66
5	6-2-13	81.7	17.3	1.0	1,128	.64
6	11-8-13	83.4	15.8	.8	1,119	.64
7	12-13-13	81.7	17.6	.7	1,133	.64
8	1-2-14	82.0	17.2	.8	1,129	.64
9	1-31-14	80.9	18.4	.7	1,139	.65
10	2-16-14	81.0	17.9	1.1	1,131	.65
11	5-1-14	81.0	18.4	.6	1,140	.65
12	6-16-14	80.9	18.5	.6	1,141	.65
13	7-1-14	78.9	20.0	1.1	1,147	.66
14	8-16-14	80.7	18.4	.9	1,137	.65
15	9-1-14	80.4	18.7	.9	1,139	.65
16	9-20-14	79.3	20.0	.7	1,151	.66
17	9-31-14	79.0	20.1	.9	1,150	.66
18	10-16-14	79.5	19.9	.6	1,151	.66
19	11-2-14	80.7	18.7	.6	1,142	.65
20	11-17-14	80.5	18.7	.8	1,140	.65

The above analyses were made by the usual combustion process. A more nearly accurate determination of the proportions of hydrocarbons present is obtainable by using fractional distillation. Such tests have shown that the proportions of heavier hydrocarbons obtained by the combustion process are consistently high. The following analyses[22] are typical of this discrepancy.

Paraffin hydrocarbons in natural gas used in Pittsburgh.

Constituents	By fractionation Per cent	By combustion Per cent
Nitrogen	1.6	1.2
Methane	84.7	79.2
Ethane	9.4	19.6
Propane	3.0	----
Butanes (chiefly)	1.3	----
	100.0	100.0

One important difference between natural gas and manufactured gas is that the former is non-poisonous. Another great difference is in the heating value, that of natural gas being just about double that of the usual manufactured gas. A third factor in favor of natural gas is its price. At the present time it is sold for only half the price obtained for manufactured gas. The result of these last two factors is that the housewife in western Pennsylvania who uses natural gas under efficient conditions can do her cooking for one-fourth of what it costs the user of other fuel.

[21]Burrell, G. A. and G. G. Oberfell, op. cit., p. 13.
[22]Burrell, G. A. and G. G. Oberfell, op. cit., p. 8.

Uses.

Natural gas can be used for lighting and heating purposes. When used with proper appliances it gives excellent illumination; but just as the gas light superceded the kerosene lamp, so now electricity is displacing gas for lighting purposes. The use of natural gas for illumination can no longer be recommended except in localitites where electricity is not available.

The chief use of natural gas has always been as a fuel. In furnaces or in kitchen stoves it is equally satisfactory, giving a steady, hot fire superior to that of any other fuel. For many heating purposes fuels are inter-changeable, the most economical winning the market and forcing competitive fuels into other fields. Thus, when natural gas was first introduced into the Pittsburgh district it was sold so cheaply that manufacturing costs were thereby greatly lowered and as a result it displaced coal for almost every heating purpose. But as the cost of obtaining and piping the gas mounted and the price of natural gas was raised to offset the increased costs, coal again became a competing fuel and it has now replaced gas in many of the industries from which it was previously driven; natural gas retaining the markets to which it is particularly adapted.

The most important use today for natural gas in the Pittsburgh district is as a domestic fuel. Second in importance, perhaps, is its use in the glass industry. No other fuel gives the same heat value at a low price and permits the same easy control of flame and temperature, which is essential in this industry. The third most important use of natural gas is in the iron industry, but this use has declined greatly in recent years. Where natural gas is produced in large volume, far from domestic or industrial markets, it is converted into lamp black, but in the vicinity of Pittsburgh the gas has always been too valuable to consider its use for this purpose.

The following quotation[23] dealing with the use of natural gas, is taken from a recent issue of "Natural Gas."

"In considering natural gas, the user, particularly the engineer too often compares our product with other fuels on a B. t. u. basis, This is very unfair unless the efficiency of utilization is also considered. One B. t. u. in gas can very often, and usually does do more effective work than one B. t. u. in a solid or liquid fuel ...... For example, some tests on a copper annealing operation indicated the ratio of B. t. u's required in coal to those in gas as being 5.2 to 1 and, for the same operation, the ratio of B. t. u's required in oil to those in gas as being 3.2 to 1.

"We must always consider that the final cost of the product should be the determining factor and not the cost of the fuel itself.

[23]Stephany, E. J. and Polk, R. E., Selling gas in competition with other fuels: Natural Gas, Vol. VII, No. 6, p. 9, June, 1926.

The following analysis of the cost of melting 100 pounds of brass is taken from the American Gas Engineering Journal of May 3, 1919:

Item	30c. Natural gas	80c. Manufactured gas	6c. Fuel oil	$10.00 Coke
Fuel	$0.12	$0.40	$0.15	$0.25
Crucible	.16	.16	.16	.266
Shrinkage	.90	.90	1.05	.90
Labor	.60	.60	.90	1.20
Totals	$1.78	$2.06	$2.26	$2.616

"Since 1919 there have been vast improvements in gas furnaces, but the table illustrates the fact that the cost of the fuel alone may not indicate the final cost and that other items in addition to the cost of the fuel must be considered."

Recent improvements in domestic appliances have made natural gas still more useful in the home. Gas heaters have been improved and made safe. House heating by gas furnaces is made automatic by use of thermostatic controls. Automatic water-heaters give an adequate supply of hot water at all times without wasting gas. The automatic, self-regulating oven of the modern gas range enables the housewife to attend to other duties while the meals are cooking, and the domestic gas incinerator makes easy the disposal of garbage. A washing machine has rcecently been invented that obtains its washing action by the percolating effect of hot suds which are heated and caused to rise by a gas flame. Other recent inventions are a gas-fired vacuum cleaner and an automatic gas refrigerating machine.

Origin and accumulation.

Although several theories have been advanced for the origin of natural gas, the one which is most strongly supported by accumulated evidence, and which is commonly accepted today, attributes its origin to organic material which was deposited along with muds and sands, millions of years ago. Differences in the character of the organic material, differences in the manner in which it was deposited, and differences in the pressure and heating to which it was later subjected, were responsible for the subsequent formation of different products, coal, petroleum, or natural gas. A full discussion of the formation of petroleum and natural gas is given in Clarke's Data of Geochemistry, fifth edition, pages 744-756, published by the U. S. Geological Survey in 1924.

For many years after natural gas was discovered in Pennsylvania it was believed to occur in northeast-southwest "streaks" which

could be located only by drilling haphazard wildcat wells. The anticlinal theory, developed in 1883 by I. C. White, State Geologist of West Virginia, gave a logical explanation for the northeast-southwest trend of the oil and gas pools known at that time and provided a practical theory to use in the location of other pools. Since then investigation has shown that the accumulation of both oil and gas is influenced by a variety of causes of which the structure and texture of the rocks are the most important. Many volumes have been written on the factors which cause the migration and accumulation of oil and gas, and the reader who is desirous of learning more of those factors is referred to them for a full discussion of the subject.

Oil and gas sands.

The oil and gas sands of the Pittsburgh quadrangle change markedly from the east part of that area towards the west (see Plates XX, XXI, anl XXII). A pronounced thinning of the sands is reflected by a much smaller proportion of sandy strata in wells drilled near the western boundary. The thinning, and sometimes the disappearance of the sands, coupled with the disappearance of the Mauch Chunk red beds and the rapid thinning of the Catskill red beds, make it a very difficult matter to correlate the sands in different pools. In the following table the oil and gas sands are listed, the geologic equivalents of drillers' names indicated, and the intervals from the base of the Pittsburgh coal to the top of the various sands and markers (such as red beds) given for each township. In using the table to determine at what depth a given sand should be encountered in any well, the distance from the top of the well to the base of the Pittsburgh coal should be determined and that interval added to or subtracted from the depth given in the table, depending upon whether the well is located below or above that coal.

In determining the average intervals to the various sands it was found that some of the sands vary widely in their stratigraphic position and others are quite constant. It was expected that the Mauch Chunk red shale and the Catskill red beds would be of great help in making correlations, but unfortunately this was not the case. The Mauch Chunk red shale is missing in the stratigraphic section throughout much of the area under discussion and where present is so thin that in many wells the drillers did not notice it. Certain red beds, generally believed to be of Catskill age, almost certainly underlie the whole area, but many drillers do not recognize their value as markers, and in many well records no mention is made of them. A third horizon at which red beds sometimes occur is below the Squaw sand and above the Berea, but apparently they are of very

Depth of oil and gas sands in the Pittsburgh quadrangle.

Interval from base of Pittsburgh coal to top of sand or "markers".

Drillers' names	Plum twp.	Patton twp.	N. Hunt. twp.	Sew'ley twp.	Eliz. and Forward	Lincoln twp.	Portvue twp.
Freeport coal	638	634	----------	644	614	628	----------
Salt sand	----------	----------	932	942	864	952	920
Second Salt sand	1,063	1,032	1,028	1,079	----------	1,041	----------
Red rock	1,134	----------	----------	1,132	1,174	----------	----------
Big Lime, Seventy-foot	----------	1,109	1,146	1,182	1,165	1,189	----------
Big Injun sand, Mountain sand	1,180	1,168	1,221	1,234	1,240	1,235	1,184
Squaw sand	1,549	1,569	1,627	1,556	1,515	1,566	1,545
Berea sand, Thirty-foot, Berea grit	1,776	1,786	1,793	1,759	1,782	1,813	1,797
Murrysville sand, Salt sand	1,878	1,890	1,906	1,871	1,866	1,895	1,878
Gantz and Hundred-foot sands	2,007	2,023	2,037	1,999	1,996	2,017	2,022
Fifty-foot sand	----------	----------	----------	----------	2,055	2,084	2,097
Thirty-foot sand	2,138	2,141	2,141	----------	2,103	2,132	1,135
Snee sand	2,183	2,188	2,218	2,167	----------	----------	----------
Red rock	2,210	2,220	2,275	2,123	2,140	2,221	----------
Boulder or Gordon Stray sand	2,219	2,239	2,273	2,262	----------	2,224	----------
Third or Gordon sand	2,280	2,312	2,306	2,338	2,270	2,302	2,269
Fourth sand	2,345	2,372	2,352	2,393	----------	2,372	2,341
Fifth sand	2,441	2,441	2,436	2,440	2,384	2,428	2,421
Bayard or Sixth sand	2,489	2,492	2,512	2,519	2,456	2,477	----------
Elizabeth sand	2,539	2,545	2,577	----------	2,524	2,540	2,595
Speechley Stray or First Speechley sand	3,220	3,205	----------	----------	----------	----------	----------
Speechley sand	3,289	3,287	3,303	----------	3,296	3,300	3,305
Tiona sand	3,420	3,417	----------	----------	3,454	3,457	----------
Sheffield sand	3,555	3,565	3,630	----------	3,597	----------	----------
First Bradford sand	3,812	3,861	----------	----------	3,802	3,846	----------
Second bradford sand	3,900	3,926	3,961	----------	3,907	----------	----------

limited extent and hence their value as a marker is equally limited. For the benefit of everyone concerned it is hoped that in the future drillers will pay more attention to these markers.

Description of sands and markers.

Freeport coal. The Upper Freeport coal is present and thick enough to be noted by drillers in about half the total area of the quadrangle. It is a marker which in certain fields, as at Versailles and near Unity Station, is the first milestone in sinking a well.

In the southwest part of the quadrangle, where wells usually start above the Pittsburgh coal, drillers sometimes record the Little Dunkard, Big Dunkard, and Gas sands. More often these variable and unimportant sands are unrecorded, or else referred to as "shells," in the general term "slate and shells" used by drillers in recording strata consisting chiefly of shale, but with some interbedded sandstone.

Depth of oil and gas sands in the Pittsburgh quadrangle.

Vers. twp.	N. Vers. twp.	Williams twp.	Penn twp.	City of Pgh.	Mifflin twp.	Jeff. twp.	Union twp.	Snowden twp.	Baldwin twp.
629	630	629	633	617	607	----------	----------	----------	603
937	----------	----------	----------	917	938	903	941	932	908
1,007	1,029	1,010	1,035	1,038	1,020	1,052	1,031	----------	1,068
1,173	----------	----------	1,117	----------	1,122	1,152	----------	----------	----------
1,117	1,174	1,160	1,119	1,147	1,155	1,172	1,143	----------	1,126
1,198	1,197	1,171	1,172	1,183	1,186	1,205	1,187	1,193	1,160
1,580	1,543	1,519	1,540	1,525	1,548	1,564	----------	1,593	1,508
1,792	1,782	1,777	1,786	1,763	1,757	1,756	----------	----------	1,736
1,893	1,897	1,871	1,871	1,858	1,862	1,842	----------	----------	1,826
2,025	2,040	2,005	2,002	1,979	1,985	1,970	1,968	1,966	1,970
2,080	----------	----------	----------	2,055	2,040	2,035	----------	2,056	2,038
2,161	2,148	2,107	2,135	2,106	2,111	2,121	----------	----------	2,103
----------	2,217	2,173	2,173	2,151	----------	----------	----------	2,148	2,137
2,191	2,222	2,133	2,194	2,132	2,177	2,139	----------	2,143	2,149
2,248	2,280	2,207	2,216	2,199	2,169	2,208	2,183	----------	2,175
2,305	2,336	2,260	2,279	2,244	2,246	2,252	2,288	2,256	2,219
2,370	2,382	2,338	2,340	2,272	2,310	2,318	----------	2,325	2,273
2,434	2,448	2,401	2,427	2,370	2,383	2,371	----------	2,382	2,344
2,481	2,517	2,446	2,495	2,417	2,443	2,448	2,416	2,445	2,462
2,548	2,581	2,544	2,543	----------	2,521	2,539	2,509	----------	2,516
3,188	----------	3,188	3,175	3,135	3,203	----------	----------	----------	3,178
3,308	3,326	----------	3,263	3,231	3,251	3,282	----------	----------	----------
3,473	----------	----------	----------	3,377	----------	3,445	----------	----------	----------
3,662	----------	3,535	3,586	3,500	----------	3,630	----------	----------	----------
----------	----------	----------	3,856	----------	3,841	----------	----------	----------	----------
3,914	3,946	----------	----------	3,900	----------	----------	----------	----------	----------

Salt sand. This sand is stratigraphically the highest of the producing sands in the quadrangle. Although fairly persistent, particularly in the southwest, it varies considerably in thickness, texture, and position. Where productive it is white and 40 to 50 feet thick. It derives its name from the fact that it frequently contains salt water. It is occasionally called the Gas sand.

Second Salt sand. This sand also frequently contains salt water and is often recorded by drillers simply as Salt sand. It is a white, hard sand, with an average thickness of 40 feet; less persistent than the first Salt Sand, and unproductive in this quadrangle.

Red rock. The Mauch Chunk red beds, occurring between the Second Salt sand and the Big Injun sand are a good marker where present, but as previously mentioned they are persistent only in the southeast part of the quadrangle. Where thickest, they occur both above and below the Big Lime, the interval from top to bottom of the red beds being 105 feet in one well. Usually they are recorded as just above the Big Lime, and only 10 to 20 feet thick.

Big Lime. The Big Lime of southwest Pennsylvania and West Virginia is undoubtedly the Greenbrier limestone. In the Pittsburgh quadrangle drillers have applied the name both to that limestone and

Sections of a series of wells extending from the downtown district, Pittsburgh, to the northeast corner of the quadrangle.

Sections of a series of wells extending across the central part of the quadrangle from west to east

Sections of a series of wells extending across the southern part of the quadrangle from west to east

to the Loyalhanna or Silicious limestone occurring close beneath it. As a result the intervals to the top of that stratum appear to vary much more widely than they really do. As a marker this bed is therefore of indifferent value.

Big Injun sand. Frequently reported in the east half of the quadrangle as a single bed 250 to 300 feet thick, this sand towards the west is usually split by one or more shale beds. Typically it is a light-colored sand of medium texture and hardness and in this quadrangle apparently is seldom sufficiently porous to contain commercial quantities of oil or gas. Where split into two parts by shale, the upper part is frequently called the Seventy-foot sand, and the lower part the Big Injun. The Big Injun is important because it is universally recognized by drillers, because it is present throughout this region, and because it thus becomes a valuable marker.

Squaw sand. This is a rather persistent and uniform sand occurring at a fairly constant horizon. It is gray or white, hard, and unproductive in this quadrangle. Usually it is less than 60 feet thick, but in some records it is double that figure.

Berea sand. The Berea sand is one of the most persistent in the quadrangle. A number of wells in Pittsburgh and Baldwin townships found commercial quantities of gas in it, but usually it is unproductive. It is sometimes recorded by drillers as the Thirty-foot sand because of its exceptionally uniform thickness of 20 to 40 feet. Usually it is described as a fine-grained, hard sandstone.

Murrysville sand. Although gas is often found in this sand, it frequently is accompanied by water, and wells which start with an initial production of over a million cubic feet a day are "drowned out" within a few weeks. In the early days of the oil and gas industry, drillers working in and near Pittsburgh called it the Great Salt Water sand because of the large volume of salt water commonly found in it. The formation is usually soft or of medium hardness, light-gray or white in color, and in the eastern part of the quadrangle ranges from 60 to 150 feet thick, averaging slightly over 100 feet. It thins rapidly towards the west however, and appears to be altogether lacking west of Snowden, Gillhall and Bruceton. In general, it is unimportant west of Monongahela River.

Hundred-foot sand. Like the Murrysville, this sand is thick in the eastern part of the quadrangle, averaging about 100 feet, and thins rapidly towards the west. It is, however, more persistent than that sand and is productive in large areas and in many different pools. It is typically a white, medium to coarse-grained sandstone, and (for this region) with a fairly high porosity. The sand usually contains

either gas, oil, or water, the water sometimes occurring in the upper part of the sand and gas or oil in the lower part.

Southwest of Monongahela River the Hundred-foot sand is usually separated into two or more parts by beds of shale. In Washington and Greene counties these parts have come to be known by the names Gantz and Fifty-foot, and the same names have been applied to the divisions of the Hundred-foot in this quadrangle. However the correlation of the divisions in Jefferson, Snowden, and Union townships is apparently in some doubt. The name Gantz, given the upper division of the Hundred-foot, is applied by many drillers in those townships to a sand occurring at an average interval of 1923 feet below the base of the Pittsburgh coal. All the evidence afforded by the drill-records available points to the fact that this is a new sand, not represented farther east, and that the real Gantz occurs at least 40 feet deeper.

Thirty-foot sand. This is a relatively unimportant sand occurring below the Hundred-foot and above the Catskill red beds. It is typically a hard, tight sand which varies considerably in thickness but is usually less than 50 feet. Commonly it is unproductive.

Snee sand. This sand occurs close beneath the Thirty-foot and usually above the Catskill red beds; occasionally however, thin beds of red shale are found between it and the Thirty-foot sand. In the greater part of the quadrangle it is thin, light-colored, hard, and dry. It attains a maximum thickness of 65 feet in the Blackadore Avenue pool in Penn township.

Red rock. The Catskill red beds are the thickest series of red beds found in the Pittsburgh region. The interval from the top of the highest red bed to the bottom of the lowest is usually 200 to 300 feet, though it is seldom that drillers record this interval accurately. The total thickness of red beds in that interval decreases markedly towards the west however, the red beds fingering out into the drab Conewango shale of western Pennsylvania and eastern Ohio. The value of this series of red beds as a marker has already been mentioned.

Boulder or Gordon Stray sand. This is a thin and unimportant sand occurring in the upper part of the Catskill red beds. Drillers record it sometimes as a red sand and sometimes as white. It is unproductive in this quadrangle.

Third and Fourth sands. These two sands occur in the lower part of the Catskill red beds and they also frequently have a reddish cast. Though usually thin, they occasionally are 70 or 80 feet thick. Occurring at almost the same horizon, correlation of these sands

between widely separated wells is often hazardous and frequently impossible. Production has been found in one or the other of them in several parts of the quadrangle. These and lower sands usually are dry unless water has been let into them from defective casing or abandoned holes.

Fifth sand. The usual position of this sand is close beneath the bottom bed of the Catskill red beds, although occasionally a red bed is found beneath it. It averages about 25 or 30 feet thick and is much more regular in its occurrence than any of the sands occurring within the Catskill red beds. Where productive the sand is open, light-colored, and of medium hardness. Elsewhere it is hard and gray. Like many of the sands already described, it thins and disappears towards the west.

Sixth sand. This sand is not so persistent as the Fifth, nor is it so productive. Its best development is in the vicinity of Trafford City where it is 35 feet thick and hard but porous.

Elizabeth sand. This sand gets its name from the town of Elizabeth, near which place it was first found to be productive. Like nearly all the sands in this quadrangle it thins from east to west, averaging about 30 feet thick in the townships east of Monongahela River and only 10 to 15 feet thick west of that river. Its color ranges from dark to white, and the texture from fine and hard, to medium and moderately soft.

Between the Elizabeth and First Speechley sands there is no sand of sufficient importance or persistence to warrant describing it. Such sands as are reported are usually thin and dark-colored. No production has been reported from any of them.

Speechley Stray or First Speechley sand. This sand is typically chocolate colored, and where productive is of medium hardness. Considerable oil, as well as gas, has been obtained from it in Plum township where it is quite regular in its occurrence and is of maximum thickness (30 feet) and importance. Lesser quantities of gas have been obtained from it in Patton and Baldwin townships. Except in Plum township the sand is apt to be irregular. It thins rapidly towards the south and west and in many places is missing.

Speechley sand. Where productive this sand is dark, porous and medium-grained. Where dry it may be light-colored or white. Large production has been obtained from it in Versailles and North Versailles townships where it is 20 to 50 feet thick. The gas is usually found in the lower part of the sand. It is locally subject to considerable variations in thickness, but in general thins from east to west.

Tiona sand. This sand is thin and unimportant in the east half of the quadrangle and apparently altogether lacking in the west half. A few wells in North Versailles township obtained small volumes of gas in it.

Sheffield sand. Like the Tiona, this sand is recorded in most deep holes as thin or lacking. No production has been obtained in it in this quadrngle.

Bradford sands. The sands of this group are quite irregular, their thickness and stratigraphic position changing considerably within short distances. They are most persistent and have been found to contain gas only in the eastern part of the quadrangle. They range in thickness from 0 to 80 feet, the average being about 30 feet. Where productive they are dark-colored, open-grained, and fairly soft. Toward the west they thin rapidly and disappear. The deepest producing horizon yet found in any well in this region is that encountered by the T. W. Phillips Gas & Oil Co. No. 2 well on the Thos. E. Mallissee farm in Plum township. Gas is obtained in this well at a depth of 3,980 feet below the Pittsburgh coal. Deeper drilling so far has failed to find gas in lower sands.

It will be noticed that in the above description continual reference is made to the thinning of the sands in a western direction. This tendency is quite marked. Provided the original supply of gas was the same in all parts of the area under consideration, the greater percentage of sand towards the east would certainly provide increased opportunity for the storage of gas in that part of the quadrangle and greater quantities of gas would be expected to occur there.

History of Natural Gas Pools.

The gas pools in the Pittsburgh quadrangle (see Plate IV in pocket) have been discovered and developed by many different companies and individuals, drilling operations having been carried on almost continuously for more than fifty years. As a result the early history of most of the pools is so scattered that to obtain it would require an unwarranted expenditure of time and money.

The Boyd's Hill well, drilled in 1875 and 1876, and located near the north end of Brady Street bridge, Pittsburgh, was one of the first wells drilled, although it failed to find either oil or gas in commercial quantities. Other dry holes were drilled in 1881 and 1882. The first gas pool to be developed apparently was the Homewood pool, discovered in 1884. About the same time the American Iron & Steel works drilled two wells in the South Side district, Pittsburgh, and obtained small production. In 1885 the Pittsburgh Bessemer Steel Company drilled a well near Homestead which struck gas in

the lower part of the Hundred-foot sand. The Philadelphia Company drilled successful wells at Wallace and Cochrans Mill in 1886 and these were followed by two or three large wells in the Third sand about midway between Bruceton and New England. About 1892 drilling became quite general along the Amity anticline between Piney Fork and Lewis Run and large production was obtained in the Salt, Fifty-foot, Third, and Fifth sands. Although the rock pressure of the Salt sand wells was not high, the initial production of many of the wells was fairly large. Early producers from the Fifty-foot sand had minute pressures of 120 to 320 pounds per square inch, and rock pressures of 360 to 450 pounds per square inch. Many of the biggest wells in the Third and Fifth sand were never gauged, but one well in the Third sand is reported to have had an initial rock pressure of 900 pounds per square inch and a minute pressure of 160 pounds per square inch; and Fifth sand wells probably gave equal or slightly higher pressures.

The large gas pool in the Elizabeth sand, near West Elizabeth, was discovered and developed in the period between 1892 and 1895. No information is available concerning the volume and pressure of the wells beyond the general statement, "Many of them were large." Some of the wells in this pool are still producing in 1926.

The Philadelphia Company drilled a well east of Sandy Creek in 1890 and obtained small gas production in the Hundred-foot sand, but this apparently did not lead to further drilling in that vicinity at that time. One of the first wells drilled in Baldwin township was that of the Manufacturers Light & Heat Company on the Woodford property between Willock and Fairhaven, drilled in 1891. Gas was obtained in the Fourth sand. Later this well was drilled through the Elizabeth sand and in 1926 it is still giving a good volume of gas from that sand.

Operators drilling for oil in the vicinity of Unity Station also found gas in the Hundred-foot and Fifth sands as early as 1893 but most of the development there did not take place until 1913, 1914 and 1915. Initial production of wells producing from the Fifth sand ran as high as 1,500,000 cubic feet per day, but the rock pressure apparently was low, a well drilled in 1913 having a rock pressure of only 82½ pounds per square inch. Gas was also found in these sands east of Wilkinsburg in the valley of Chalfont Run in 1894 and 1895, rock pressure in the Hundred-foot being reported as 38 pounds per square inch in one hour, and in the Fifth, 156 pounds per square inch. Small production was obtained in the Elizabeth sand in the southeast corner of Penn township at about this same time, the original rock pressure being 600 pounds per square inch.

The search for oil north of Sandy Creek in the period between 1895 and 1900 was rewarded also by the discovery of gas in both the Hundred-foot and Murrysville sands. All of the wells drilled at that time have since been abandoned. A good pool in the Elizabeth sand was discovered near Lincoln Place about 1896; the wells in this pool also have been abandoned for many years. A small pool in the Hundred-foot sand just south of Homestead is apparently the only one discovered in 1899. One of the wells in that pool is still producing after 27 years.

In Lincoln township, drillers discovered gas in the Elizabeth sand in 1901 and large pools were developed there in that and succeeding years. The initial rock pressure of the gas was high, as evidenced by the fact that one well, completed in June, 1904, gauged 550 pounds pressure in 30 minutes; and that another, completed in February, 1901, had a rock pressure of 1425 pounds per square inch in February, 1915.

The New England pool was discovered about 1902. In 1903 the Greensboro Gas Company found large production in the Murrysville sand in a well drilled on the Thomas Martin property. Several other wells were drilled in hopes of finding additional large production but all of them were failures.

W. F. Minteer, an independent operator, discovered gas at East Pittsburgh in 1904 and since then has drilled nine or ten other successful wells in the same vicinity. The gas comes from the Fourth sand, wells starting with an initial pressure of 350 pounds per square inch and a production of 50,000 to 555,000 cubic feet per day.

Between 1904 and 1912 there was a lull in drilling operations in this area, but higher prices for gas led to renewed efforts, and in the period between 1912 and 1922 great numbers of wells were drilled and the possibilities of gas production from this area quite thoroughly tested. One of the first pools to be discovered in this new campaign was the Bradford sand pool in the northeast corner of the quadrangle. The initial production of wells was small, however, and the pressure apparently much lower than is usual in the case of Bradford sand wells. Considerable production was obtained in the Fifth sand in the same locality, and a small pool was also developed in the Speechley sand. One well drilled to the latter sand in 1921, had an initial production of 535,680 cubic feet, with a rock pressure of 850 pounds per square inch. Another, completed in August, 1921, gauged 22 pounds in 10 minutes in $6\frac{5}{8}$-inch casing. South of Sandy Creek gas was obtained in the Thirty-foot (possibly the Snee) sand and the Fifth sand in 1913 and succeeding years. Production from the Thirty-foot was small, but some of the wells in the Fifth gauged over 500,000 cubic feet per day. A rock pressure of 290 pounds per square inch was obtained in one of the first Fifth sand wells.

About 1913 the Carnegie Natural Gas Company started a drilling campaign in Mifflin township between Lincoln Place, Hays, Homestead and Duquesne, and considerable gas was obtained, chiefly in the Fifth sand. One well in Munhall Borough gauged 110 pounds in the first minute and 401 pounds in 30 minutes. Another well, located near Hays, gauged 30 pounds the first minute and had an initial production of 159,000 cubic feet.

The South Hills Oil & Gas Company drilled a number of wells in Baldwin township in 1913, 1914, and 1915 and developed a number of fair-sized gas pools. The Manufacturers Light & Heat Company, the Carnegie Natural Gas Company, and one or two local companies have also drilled a few wells in this same area. In the Hundred-foot pool west of Willock, one well had an initial production of 3,000,000 cubic feet with a rock pressure of 775 pounds per square inch, and another well gauged 850,000 cubic feet with a rock pressure of only 235 pounds per squre inch. The Stella Hays No. 3 well, near the mouth of Becks Run, also found gas in the Hundred-foot and gauged 480 pounds after being shut in for only 5 minutes. Sankey No. 1 well, located near Carrick, got 304,320 cubic feet of gas in the Thirty-foot and 50,000 cubic feet in the Sixth sand, the combined rock pressure from these two sands and the Fourth being 680 pounds per square inch. Most of the wells drawing their gas from the Fourth and Fifth sands had initial rock pressure of 400 to 750 pounds per square inch; however one well, the Hays Heirs No. 1, actually gauged 900 pounds pressure in one hour, the gas coming from the Fourth sand. One well producing from the Speechley had an initial rock pressure of 800 pounds, and another, 11 pounds in one minute in 2-inch tubing.

The Trafford City pool was largely developed in 1917, wells having initial productions of 38,000 to 1,456,000 cubic feet, and rock pressures ranging from 140 to 835 pounds per square inch. One well north of the Trafford City station got about 107,000 cubic feet of gas in the Hundred-foot with a pressure of 600 pounds per square inch in one hour.

The gas pools in North Versailles township and the north half of Versailles township were largely developed in the period from 1915 to 1919 inclusive. Many large wells resulted, the biggest wells producing from the Hundred-foot or from the Speechley sands, but good production also was obtained from the Murrysville and Elizabeth sands. Wells in the Murrysville produced as much as 2,800,000 cubic feet per day, under a rock pressure of 300 pounds per square inch, but production from this sand usually was short-lived. Many of the wells in the Hundred-foot sand were large, one well producing 11,711,000 cubic feet initially, another 10,981,620 and another 8,899,878. The largest well ran up a pressure of 260 pounds in the

first minute and other wells had rock pressures of 1,070 to 1,200 pounds per square inch. Few, if any, of the wells which found gas in the Elizabeth sand produced over 800,000 cubic feet initially. At least three, however, produced over 700,000 cubic feet at the start, the gas being under a rock pressure of over 750 pounls per square inch, that pressure having been recorded in a well drilled some years after the first wells tapped this sand. A number of wells in the Speechley sand produced over a million cubic feet at the start, but the average initial production was probably only half that amount. One well, the Spiegel, located about a mile south of East McKeesport, is reported to have had an initial production of about 100,000,000 cubic feet of gas a day from the Speechley sand, but apparently it was never gauged, and the figure cited is probably at least twice too large. Whatever the production, the well blew down very quickly. Wells producing from the Speechley sand had initial rock pressures of about 700 pounds per square inch.

The Carnegie Natural Gas Company and the Peoples Natural Gas Company obtained small gas production in the eastern part of Wilkins township in several wells drilled in 1917. In 1918 the Philadelphia Company considerably extended the Elizabeth sand pool north of Monroeville, originally discovered by the American Natural Gas Company in 1914. The rock pressure of wells in this pool ranged from 700 to over 850 pounds per square inch, but the production was small.

The large production obtained at McKeesport in the Speechley sand pool in 1919 and 1920 caused an extended wildcat campaign in many of the adjoining townships. Most of these wells were failures, but one or two small pools were discovered as a result. One of these pools is the Elizabeth sand pool in the valley of Hayden Run, south of Elizabeth. The Andrews well in that pool had an initial production of several million cubic feet, but other wells were small. The initial rock pressure of the Andrews well was 825 pounds per square inch. The small pool discovered in the Murrysville sand along Ninemile Run was another development in 1920, initial productions ranging from 1,000,000 to 3,000,000 cubic feet, according to report. The Fifth sand pool between Swissvale and Rankin was developed chiefly by one local company, the Swissvale Oil & Gas Company, wells in that pool ranging in size from 50,000 to over a million cubic feet.

The Blackadore Avenue pool north of Wilkinsburg is the most recent of the natural gas pools to be discovered in this quadrangle. Some gas was obtained in the Fifth sand, but most of it comes from the Snee sand. Few of the wells produced over 500,000 cubic feet initially, most of the later ones producing much less than that

Plate XXIII. Panorama of McKeesport gas field taken when the gas boom was at its peak. This is the southern part of the field at Versailles. Seen from across Youghiogheny River.

Photographed by Wood & Landon, McKeesport, April 12, 19[illegible]

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The Blackadore Avenue pool north of Wilkinsburg is the most recent of the natural gas pools to be discovered in this quadrangle. Some gas was obtained in the Fifth sand, but most of it comes from the Snee sand. Few of the wells produced over 500,000 cubic feet initially, most of the later ones producing much less than that

amount. Rock pressure at the start averaged about 450 pounds per square inch.

McKeesport gas pool.

The dramatic rise and fall of the production from the McKeesport gas pool is known in a most painful way to a great many people living in the Pittsburgh district—painful because the rapid decline in the production of that field soon made worthless the great majority of securities which had been peddled far and wide in the early days of the gas boom. The development and decline of the pool was described at the time in mimeograph bulletins issued by the State Geologist,[24] but for the sake of incorporating the information about the pool in more permanent form, and for the benefit of those who might now and in the future wish to study this pool or compare it with others, the story will be briefly repeated here.

Early history. The name "McKeesport gas pool", as used in this report, is attached only to the Speechley sand pools developed in 1919 and 1920, and located chiefly in Versailles, Snake Hollow, and the eastern part of McKeesport.

The more general term, "McKeesport gas field" includes all the pools along the crest and flanks of the Murrysville anticline between Youghiogheny River and Brush Creek.

The McKeesport pool was discovered in the extension of a drilling campaign which had already developed good production in the Speechley sand in the southeast part of North Versailles township and the northeast corner of Versailles township. The No. 1 well on the Frank Storch farm, completed by the Philadelphia Company on April 9, 1919, seems to have been the first well drilled to the Speechley sand in the McKeesport pool. The initial production of this well was about 1,500,000 cubic feet. It was followed by the Wiggins No. 1 well of Dave Foster and Sam Brendle, completed on August 1, 1919, with an initial production of 6,000,000 cubic feet. The third well to be completed to the Speechley sand was the No. 3 well on the Hamilton lease, also owned by Foster and Brendle. This well was completed on August 23, 1919, and although its initial production was only 4,000,000 cubic feet, it quickly increased this and on August 29, when it was turned into the line of the Peoples Natural Gas Company, the production was 24,861,000 cubic feet. The production continued to increase until September 24 when a maximum of 56,117,000 cubic feet was reached. Contracted for at a price of 17 cents per thousand

[24] Ashley, G. H., Development and probable life of gas pool at McKeesport, Pennsylvania: Pennsylvania Top. & Geol. Survey, Bull. No. 3, Nov. 28, 1919.

————————, Decline of McKeesport gas pool: Pennsylvania Top. & Geol. Survey, Bull. No. 4, Dec. 26, 1919.

————————, The McKeesport gas pool; Pennsylvania Top. & Geol. Survey, Bull. No. 5, Jan. 12, 1920.

Robinson, J. French, Production of the McKeesport gas pool: Pennsylvania Top. & Geol. Survey, Bull. No. 19, Jan. 24, 1921.

cubic feet, the production from this well represented a daily income to the owners of about $8,500.00. One day's production repaid the entire cost of the well. Is it any wonder that thousands of people residing in the Pittsburgh district and struggling to make a bare living were tempted to invest their savings in other companies which sprang up overnight and which professed to have leases within stone's throw of the big well?

At first little publicity was given the big well, but as other wells started by Foster and Brendle and by the Philadelphia Company also began to come in with big productions, excitement became intense and by December 1 no less than 116 companies had been formed and 230 proposed wells located. By the evening of January 10, the number of companies planning to drill in this one district had been increased to 297. Had the McKeesport pool been located in an area where the land was divided into farms of an average size, all of the likely leases would probably have been quickly seized by 5 or 6 of the large gas companies, and a few small operators or local companies. It so happened however that the pool was located in a highly developed area where much of the ground had been sub-divided into lots. As a consequence there were hundreds of leases available close to the big producing wells, and as each property owner demanded that at least one well be drilled on his property, the land adjacent to the big wells soon began to have the appearance of a strange forest, derricks arising in every direction and in some cases being so close together that they actually over-lapped (see Plates XXIII and XXV).

Early in November the State Geologist, Dr. George H. Ashley, visited the McKeesport pool, and following his examination of conditions made a prediction that, "If one-half of the gas wells now projected in the McKeesport gas district are drilled, the immediate field will do well to last two years as a large producer of gas." This statement, instead of causing a cessation in drilling, was greeted by open derision, for, "was not the big gusher still producing more than 40,000,000 cubic feet of gas a day?" Drilling continued on an ever increasing scale. Again in December, Dr. Ashley visited the field, and this time there were a few ready to listen to his warning that "further drilling in the McKeesport pool must result in serious financial losses," for those in the field knew that the average initial production of new wells in December was far below the average initial production of the first wells, and the rock pressure of wells was dropping at an alarming rate. Nevertheless the uninformed continued to invest in McKeesport stocks and more companies were incorporated and more contracts let for the drilling of wells. By the middle of January the rapid decline in the production of wells could no longer be concealed or denied, but by that time over 600 wells had been contracted for and over a thousand wells were contemplated. When one

considers that the total area of Speechley sand production in the McKeesport pool is only 864 acres and that one well can easily drain 80 acres, the over development of the McKeesport gas pool seems almost criminal.

Production. The following table contains data relative to some of the large wells in the McKeesport pool.

Wells in McKeesport pool.

No. on map	Owner of property, or name by which it is known	Owner of well	Initial rock pressure in pounds per sq. in.	Initial production in cu. ft.	Gauged -G or Estimated E
1	Hamilton, well No. 3	Foster and Brendle	1400 (E)	4,000,000	G
	Hamilton, well No. 3	biggest day's production		56,117,000	G
2	Peterson	E. W. Pitts No. 1		30,000,000	E
3		Reynolds No. 1		27,672,000	G
4	Stewart (?)	Fisher No. 4		22,000,000	G (?)
5	Henry Groff	Versailles O. & G. Co.	240	20,000,000	E
6	Annie Smith	Lamp-Auld No. 1		15-20,000,000	E
7	Stewart No. 1	Dave Foster		20,000,000	E
8	Peterson No. 1	Foster & Brendle		18,000,000	G (?)
9	Palkowitz No. 1	Weill		15,500,000	G
10	J. W. McClelland	Mathews-Robb No. 3		15,000,000	E
11	Peterson No. 2 (Impong)	Foster & Brendle		15,000,000	E
12	Pitts	E. W. Pitts No. 2		15,000,000	G
13	Mendelowitz	Bissell O. & G. Co.		12-15,000,000	E
14	Stanley	Mac Wolt No. 1		8-15,000,000	E
15	Austen Conrad	Roosevelt O. & G. Co		14,741,000	G
16	Hamilton No. 4	Foster & Brendle		12,000,000	E
17	Hannah Pratt	Grandview O. & G. Co.		{12,000,000 } 5,856,000	E G
18	Kellerman	Olympia No. 2		11,770,000	G
19	Allen	Paramount No. 1	190	11,000,000	G
	Bowman	United-McKeesport No. 1		10,170,000	G
20	Handle	John H. Hartman, Jr.		{10,000,000 } 3,100,000	E G
21	H. S. Shupe	Valley View No. 1		{10,000,000 } 2,500,000	E G
22	Howard	F. C. Howard & Co.		10,000,000	E
23	Hammer	Cordock O. & G. Co. No. 1		10,000,000	E
24	Huffman	Hodges O. & G. Co.		10,000,000	E
25	Marks	Marks O. & G. Co.		10,000,000	E
26	Peterson	Sloan & Wally		8-10,000,000	E
27	Whitehouse	Harrison O. & G. Co. No. 2		10,000,000	E
28	Marsh	Keystone O. & G. Co. No. 3		9,114,000	G
29	Otto Greenwalt	Philadelphia Company	230 lbs. in 20 mins.	8,604,000	G
30	Eakin	Guffey No. 2		8,309,000	G
31	Serena	Serena O. & G. Co. No. 1		8,250,000	G
32	Wiggins	Philadelphia Company	740	5,497,000	G

It will be noted that one well having an estimated production of 12,000,000 cubic feet, actually produced only 5,856,000 cubic feet; that another having an estimated production of 10,000,000 cubic feet, produced only 3,100,000 cubic feet; and that a third well produced only one-quarter of the estimated production. These figures are quite in accordance with common experience, the estimated production of wells habitually being more than double the actual production. In view of that fact it is probably safe to say that not more than 13 wells in the McKeesport pool had an initial open-flow production of over 10,000,000 cubic feet.

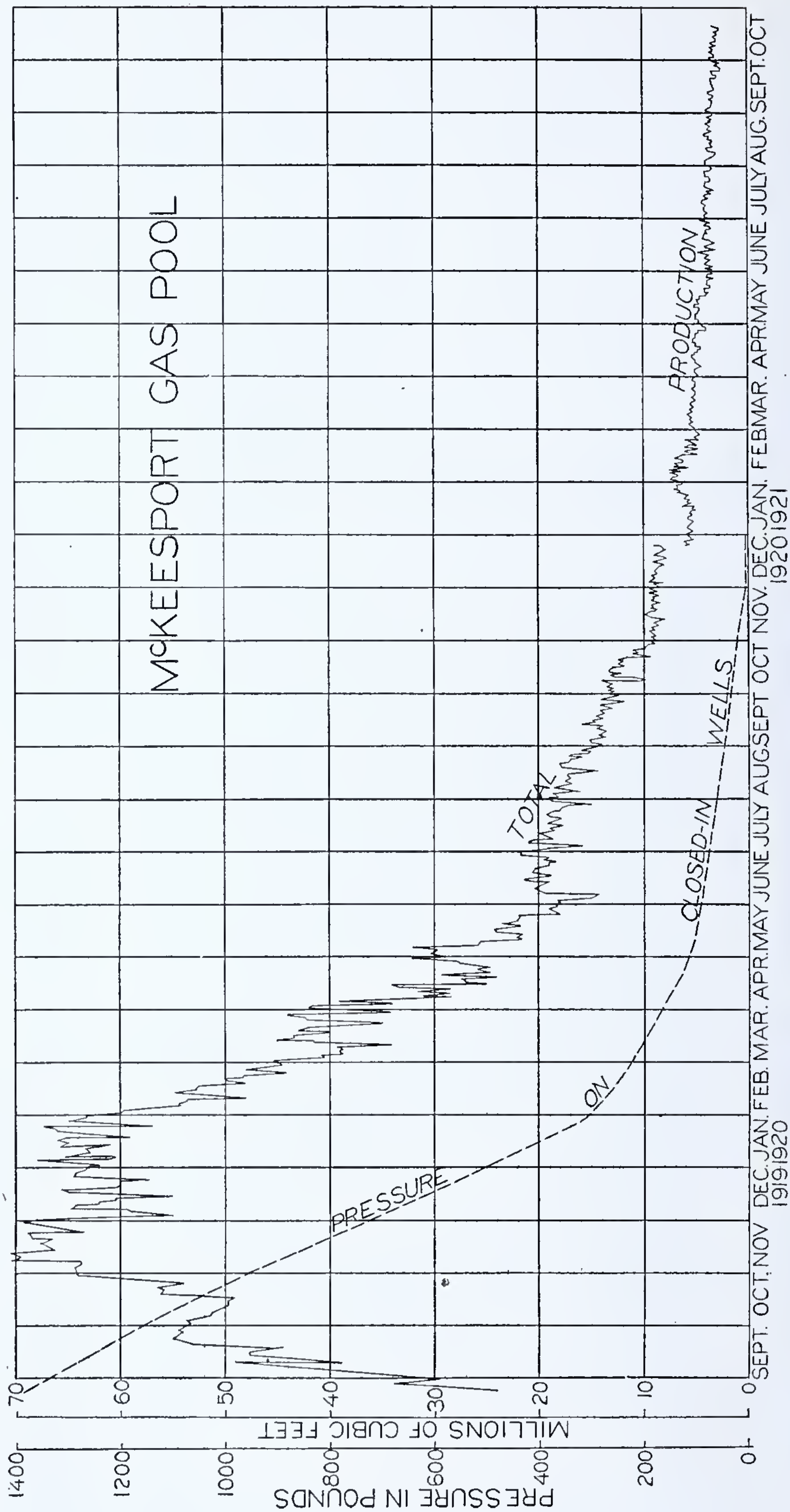
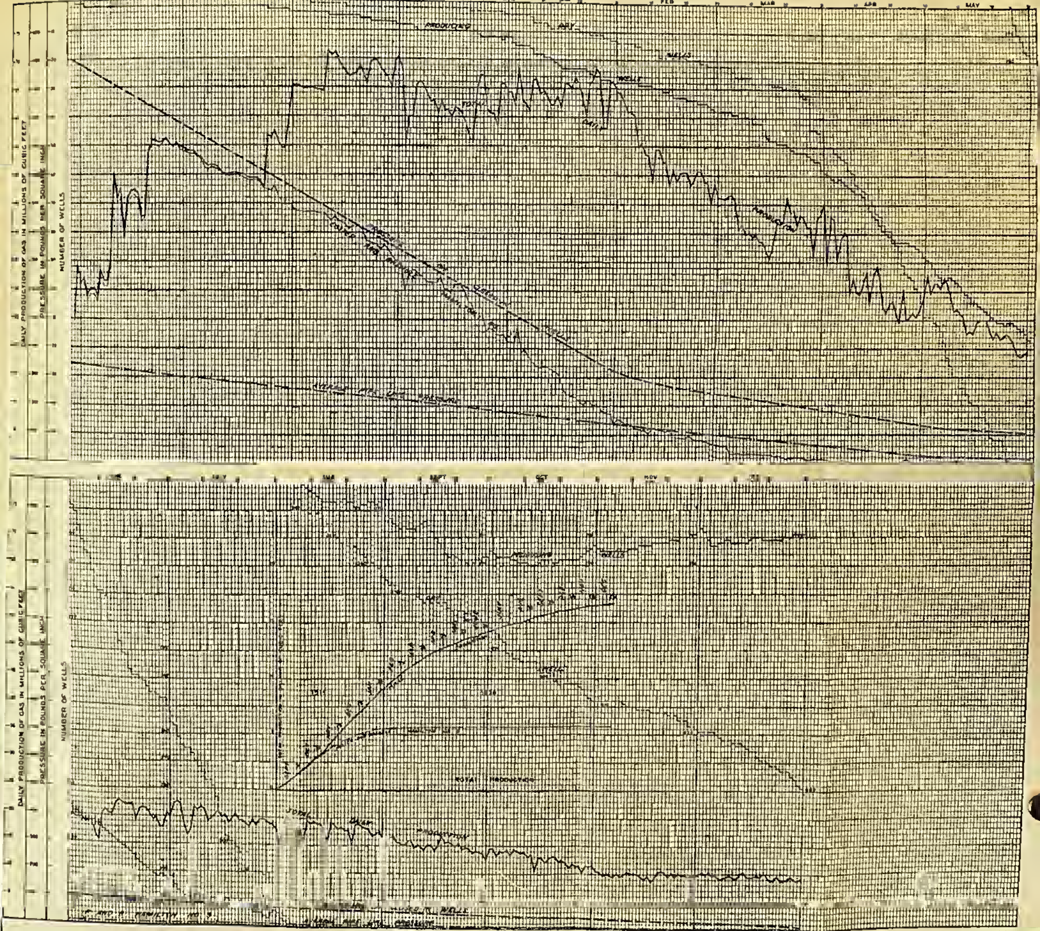


Figure 23. Production and pressure in McKeesport gas pool.

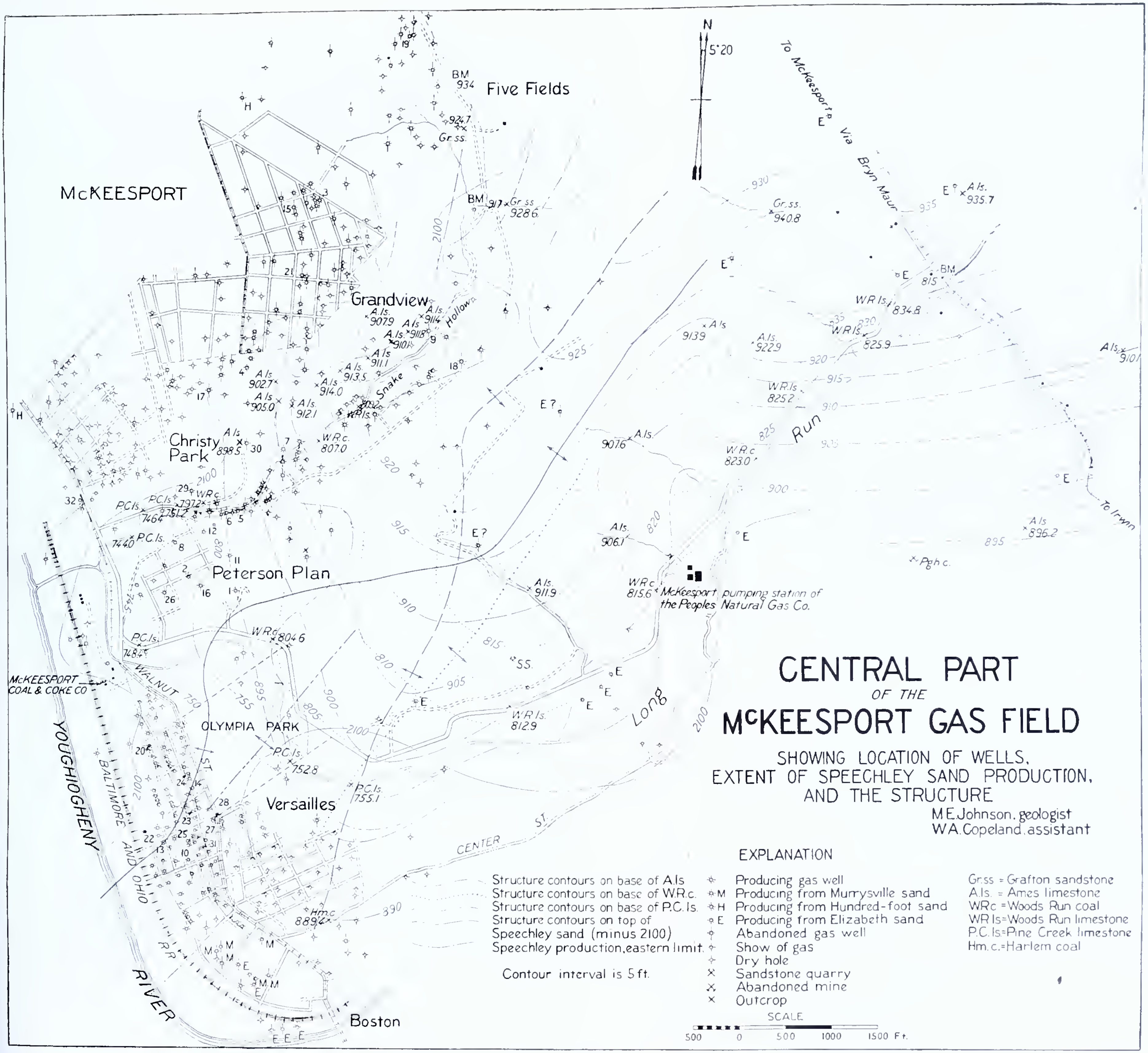
PLATE XXIV



Data relative to the McKeesport gas pool.

Prepared by F. French Robinson.

O. P. Solem, del.


CENTRAL PART
OF THE
McKEESPORT GAS FIELD
SHOWING LOCATION OF WELLS,
EXTENT OF SPEECHLEY SAND PRODUCTION,
AND THE STRUCTURE
M.E.Johnson, geologist
W.A.Copeland, assistant
EXPLANATION
Structure contours on base of A.ls.
Structure contours on base of W.R.c.
Structure contours on base of P.C.ls.
Structure contours on top of Speechley sand (minus 2100)
Speechley production, eastern limit.
Contour interval is 5 ft.
Producing gas well
Producing from Murrysville sand
Producing from Hundred-foot sand
Producing from Elizabeth sand
Abandoned gas well
Show of gas
Dry hole
Sandstone quarry
Abandoned mine
Outcrop
Gr.ss = Grafton sandstone
A.ls. = Ames limestone
W.R.c = Woods Run coal
W.R.ls = Woods Run limestone
P.C.ls = Pine Creek limestone
Hm.c. = Harlem coal
SCALE
500 0 500 1000 1500 Ft.
McKEESPORT
Five Fields
Grandview
Christy Park
Peterson Plan
OLYMPIA PARK
Versailles
Boston
YOUGHIOGHENY RIVER
BALTIMORE AND OHIO RR
WALNUT ST.
CENTER ST.
Long Run
Snake Hollow
McKEESPORT COAL & COKE CO.
McKeesport pumping station of the Peoples Natural Gas Co.
To McKeesport via Bryn Mawr
To Irwin

From a study of production and pressure records Dr. Ashley estimated in the early part of January, 1920, that "the Long Run (McKeesport) pool did not contain at the beginning over 15 to 20 billion cubic feet (of gas)." Time has proven the accuracy of his estimate; for Mr. J. French Robinson, geologist for the Peoples Natural Gas Company, recently computed the total actual production from August 29, 1919, to October 1, 1925, to be 21 billion cubic feet. This production would never have been obtained however if pumps had not been installed by the Peoples Natural Gas Company and the Manufacturers Light & Heat Company. By means of the pumps, pressure at the wells was reduced to a few pounds (wells in the outer part of the field) or a vacuum of 12 inches (wells near the pumps) as long ago as January, 1921. Most of the wells that have been in the line since that date would have been abandoned in 1920 or 1921 had it not been for the installation of the pumps.

Data relative to the early history of the McKeesport field is contained in Plate XXIV, reproduced from Bulletin No. 19 of the Pennsylvania Topographic & Geologic Survey. The explanation of the chart is repeated verbatum.

"To those not familiar with the use of graphic charts the following explanation will be helpful: from the attached chart one can observe the daily production for any day desired from August 29, 1919, to December 31, 1920. For example, November 10, 1919, gives the peak or "big day" production for the pool, namely 71,530,000 cubic feet of gas. Just above the daily production curve is shown the graph of the number of producing wells. On that day the number was five. ...... On the total production curve at November 10 is given the amount of gas the field has produced to that time, namely 3,725,939,000 cubic feet. The pressure curves for the same date show the "closed in" pressure to be 900 pounds per square inch, and the average line pressure to be 250 pounds per square inch. The daily production of the "big" well can be read in the same manner as the daily production of the field and is 42,772,000 cubic feet; its total production to November 10, 1919, was 3,386,423,000 cubic feet of gas. In like manner the behavior of the whole field can be had for any day during the sixteen producing months."

Conditions affecting production in the McKeesport pool. The six factors which have controlled the production of individual wells in the McKeesport pool, can be grouped as follows:

Natural factors:
1. Structural conditions
2. Porosity and texture
3. Thickness of the producing sand

Operating factors:
4. Date that well was completed
5. Spacing of wells
6. Care of wells

1. The first factor has already been briefly commented upon in the section on STRUCTURE. The big Speechley sand pool of the McKeesport field is located chiefly on the northwest flank of the Murrysville anticline and between the 1200 and 1225 foot structure contours (see Plate IV). The south tip of the pool is on the crest of the anticline and extends a little below the 1200 foot structure contour. The north tip also extends a little below that contour. Big wells were obtained in all parts of the pool, but time has shown that those on the apex of the structure, even though spaced very closely, have had longer lives on the average than those on the flanks of the structure. The Bryn Mawr and Lincoln Way pools, to the north and northeast respectively of the big pool, are also located on the northwest flank of the Murrysville anticline, but their location, shape, and extent seem to depend chiefly on other factors.

When plane-table work in the McKeesport district was undertaken it was hoped that a structure map could be prepared showing contours on the top of the Speechley sand. Unfortunately the drill-records that had been obtained were found to be so inaccurate that the preparation of such a map proved impossible and the idea had to be abandoned. The one contour which seemed fairly reliable, the minus 2100 foot contour, seems to show that although surface structure reflects underground structure in a general way, details of the underground structure can only be determined by the drill. Minor folding appears to have had very little effect upon production.

2. The Speechley sand in the McKeesport district is medium to fine-grained. Where productive the sand is medium-grained and consists almost wholly of white quartz grains, in part stained with iron. Under a lens the white quartz grains are very conspicuous, but as seen with the naked eye the sand has a light-brown color. Where unproductive the sand is considerably darker in color, due in part to the admixture of gray, slaty material and in part to a greater degree of staining by the iron compounds present. So far as known the porosity of the Speechley sand from the McKeesport pool has never been determined, but comparison of this sand with others leads to the belief that it probably ranges from 5 to 18 per cent. The porosity of the sand is believed to have been the chief factor in determining the amount of gas obtained by wells which were not influenced by operating factors.

3. The Speechley sand ranges from 0 to 50 feet thick in the McKeesport district. Though the thickness of the sand is an important factor in determining the amount of gas that a sand may hold, very few of the dry holes in the McKeesport district failed to find some sand. Evidently this factor played a small part in determining the production of individual wells. Further evidence to this effect is afforded by the fact that well No. 1 of Mansfield, Cook & Steel on

the Miller farm, Snake Hollow, found only 30 feet of Speechley sand but had an initial open flow of over a million cubic feet; whereas well No. 2 on the same farm had "45 feet ofthe finest-looking gas sand that has been seen at any location in the local field," yet it was dry.

4. Practically all of the first wells that were drilled within the limits of the McKeesport pool obtained good production in the Speechley sand. But as more and more wells were drilled, the gas was rapidly exhausted and late completions usually found the sand so nearly dry that many of the wells were never even turned into a gathering line. It is this factor which impels operators in any pool where the ground is greatly divided, to drill their wells just as fast as they can; and for the same reason, good well-logs in such a pool are almost never kept, every effort being expended towards greater speed in drilling. The same factor, date of completion, is responsible for the strange mixture of producing wells and dry holes shown in Plate XXV.

5. Attention has already been called to the extremely close spacing of wells in the McKeesport pool. It was chiefly due to this factor that the major part of the gas from the McKeesport pool was obtained (at a most exhorbitant cost) in a period of 15 months, instead of serving as a reserve which could be drawn upon for a period of ten or fifteen years. Over 600 wells were drilled in an area that could have been drained by ten.

The spacing of wells should be determined by the porosity of the producing sand, only that number of wells being drilled which will drain a given pool in an economical length of time. In this quadrangle however, the determining factors have been the high price paid for gas, and the fact that much of the land is divided into small farms or city lots. These factors have not lead to the most economical development of the gas pools, but they have led to a complete development.

6. Many of the companies formed at the time of the McKeesport boom were in such a hurry to drill their wells to the Speechley sand, that they failed to case their wells properly. As a consequence water accumulated in the holes until eventually it reached a depth sufficient to overcome the pressure of the gas and the production of the wells was suddenly terminated. Trouble from water is largely eliminated by drilling 100 feet or more of hole below the producing sand; but in the McKeesport pool most of the producing wells were turned into the line when the drill reached the bottom of the Speechley sand, few wells having more than 20 or 30 feet of water pocket. Some wells which found only small production in the Speechley sand were abandoned, often without complying with the State regulations relative to the plugging of abandoned wells, and the gas from these wells was allowed to escape into the air. Some of these abandoned

wells were still producing gas in the summer of 1925 when the writer completed work in the vicinity of McKeesport. Though the loss each day from each well would be small, the total loss from all improperly plugged wells must be large.

Finally, certain wells have continued to produce long after neighboring and larger wells ceased to flow, because they had been cleaned out from time to time. The life of a well can sometimes be prolonged for years by removing the water and mud which are bound to accumulate in any well after it has been in the line for several years.

Cost of drilling and value of gas produced. The story of the McKeesport pool would not be complete without some mention of the cost of the wells drilled, and of the returns in the shape of dividend checks to investors.

The Hamilton No. 3 well, the first big "gusher", is reputed to have cost less than $8,000. The Lee Hirshberg No. 1 well on the Kalkbrenner lease in the lower part of Snake Hollow was drilled for a total cost of $13,416.58. The S. W. Broman well of the Olympia Gas Company, known as the Olympia No. 1 well, was capitalized for only $12,400.00. These were among the first wells drilled. As the "boom" got under way costs mounted rapidly, so that by January, 1920, most wells were being capitalized at $30,000 to $40,000. Contractors demanded $10,000 or more for drilling a well and the cost of leases jumped from almost nothing to $5,000 or more for a city plot. The following are some of the worst examples of what "boom" promoters bring about.

Muir-Reed proposition—one well on the Becker property, Snake Hollow. Paid $25,000 for a lease 75 by 160 feet. Company capitalized for $50,000. Dry hole.

Foster-Adams four well proposition. Capitalization, $200,000. One producing well with an initial flow of 1 million cubic feet.

Tri-State Oil & Gas Co. Capitalization $60,000. Drilled one well, dry.

Aladdin Oil & Gas Company. Four well proposition, capitalized at $300,000.

Tube City Oil & Gas Company. Twelve well proposition, capitalized at $500,000.

United Oil & Gas Company. Four well proposition, capitalized at $300,000.

One man requested a permit to drill one well with a capitalization of $100,000, but the permit was not granted.

The following statement was issued by Kunze and Carroll regarding their Three Star proposition:

Receipts		$38,253.09
Disbursements		
Stock-selling expenses	$ 3,683.50	
Cost of leases	23,000.00	
Paid on drilling contract	5,000.00	
Casing	3,780.47	
Rig irons, hauling, labor, freight, etc.	2,789.12	
		$38,253.09

Stockholders were assessed $30 a share in order to raise funds to complete the well, the estimated cost of completion amounting to $10,000.

Twenty thousand dollars would probably be a conservative figure for the average cost of all the wells drilled in the McKeesport pool. Since about 650 wells were drilled in and near the pool during the boom, at least $13,000,000 was spent in drilling. The gas obtained was sold at prices ranging from 10 cents to 18 cents per thousand cubic feet, fifteen cents probably being a fair average. At that price the field has to date produced gas worth about $3,150,000. If pumps had not been installed, production would probably never have exceeded 15 billion cubic feet and the total value of the gas produced would have been $2,250,000. Even with the aid of a powerful vacuum, production is now very low and it is doubtful if the total value of the gas produced will ever reach $3,500,000. Surely such a loss—$9,500,000—should cause future investors to think twice before putting their money in town-lot drilling companies.

Leasing methods.

Many of the leases contracted by property owners in this quadrangle have proven inequitable; sometimes to the gas company, more often to the farmer. In the past, leases have usually involved a fixed yearly rental of $100, $200, perhaps $500 depending upon the size of the property, the bargaining power of the property owner, and the competition between natural gas companies. Leases also usually stipulated that the lessor, that is the property owner, should have all the free gas he desired. As a result of the fixed royalty, farmers did not get a fair return in case large production was obtained from the lease; and as a result of the "free gas" clause, farmers usually were very wasteful with gas. If only small production was obtained and the gas company had contracted for a large yearly rental, then the well was abandoned and everybody lost. Usually also, a lease was abandoned as soon as the gas company owning the lease found that the production was not sufficient to pay the rental plus operating charges. Occasionally a lessor would agree to a reduction in the

rental, but more often he would demand that the company adhere strictly to all the provisions of the lease.

The modern lease usually contains provisions whereby the royalty is reduced if production proves small, and other provisions which limit the free gas to the land owner to a definite amount. Accordingly many small wells are now retained which would otherwise be abandoned, and the land owner receives free gas and perhaps $25 a year rental that he would lose with the old type of lease.[25]

Future development.

Situated in a region where the demand for gas is large and where a good price is paid for gas at the well, operators have tested almost every square mile in the hope of discovering other pools. Many more wells have been drilled than are shown on the map. The map shows only those wells which were actually seen by the writer and perhaps a dozen which can no longer be seen, but the location of which is vouched for by the men who drilled them.

Other small pools will undoubtedly be discovered. Pools already discovered will be extended. But there may never be another "McKeesport boom" in this quadrangle.

Wells sunk below the Speechley sand have so far failed to profit their owners except those drilled in the northeast corner of the quadrangle. Several wells have been sunk to a depth of more than 4,500 feet below the Pittsburgh coal without finding a productive horizon. Only one hope seems to remain, namely, the possibility that the Oriskany and Medina sands may contain gas in this area. Drilling to the Medina sand is almost out of the question at the present time as it lies at an estimated depth of 8,000 feet or more in every part of the quadrangle; but the Oriskany is within reach of the drill at several points. At Versailles, which is considered to be the best location for deep drilling, the Oriskany is estimated to be 6,620 feet below the surface. About a mile from the mouth of Ninemile Run, the depth should not be more than 6,500 feet because of the known thinning of the strata from southeast to northwest. In the little valley between Sandy Creek Station and Verona the interval should not be over 6400 feet; but since the Amity anticline is not very pronounced there, that location is considered inferior to the first two mentioned. Finally, a location in the valley of Brush Creek at the east boundary of the quadrangle might well prove best because of the pronounced folding of the rocks there and the large gathering area from which gas could accumulate. A location there, however, would involve drilling to an estimated depth of more than 6,900 feet.

[25]For further information regarding modern leasing methods the reader is referred to articles on that subject in the May and June, 1926, issues of the magazine "Natural Gas," and to Johnson, Huntley and Somers' book, the "Business of Oil Production."

Lest anyone become too enthusiastic about drilling to the Oriskany sand, it should be remembered that a well 6,500 feet deep costs from $50,000 to $100,000, depending upon the skill of the drillers, trouble from caving, etc. Also, it must be remembered that so far only one well has found gas in the Oriskany sand in this State—and the production from that one was not large.

PETROLEUM.

Crude oil, or petroleum, has been found in three different sands in this quadrangle; namely, the Hundred-foot, Fifth, and Elizabeth. The oil from all three of these sands is greenish-yellow when held towards the light in a glass bottle, and dark green when seen in a tank. The specific gravity of the oil ranges from 40° to 43° Baumé and it flows easily at temperatures down to freezing. The oil has a paraffin base and yields about 25 per cent gasoline by straight-run methods.[1]

History of oil pools.

The Unity Station pool is by far the largest of the oil pools in this quadrangle. Oil was first discovered there about 1893 and some of the first wells produced as much as 100 barrels a day. Most of the wells are still being pumped, but their average daily production is only about half a barrel now.

The small pool in the Elizabeth sand near West Elizabeth was discovered about the same time as the Unity Station pool. About half a dozen wells produced oil in paying quantities. The initial production of the wells is unknown, but they are not believed to have been large. One well in the group is known to have produced only 10 barrels a day. The oil was piped by gravity to a loading rack at West Elizabeth and shipped from there to Pittsburgh by rail. All of the wells are abandoned now.

The small oil pool in the Elizabeth sand north of Wilmerding is believed to have been discovered by the Patton Oil & Gas Company about 1892; but the Philadelphia Company drilled most of the wells. Wells produced about 10 barrels a day initially. All of them have been abandoned for a number of years now.

Several wells were drilled northeast of Sandy Creek station between 1895 and 1900, and a well on the Brown property produced 100 barrels of oil a day for several weeks; but the pool proved to be very limited in extent, and the total production must have been small. The wells have all been abandoned for ten years or more.

A still smaller pool in the Hundred-foot sand was discovered west of Sandy Creek about 1905. Only three or four wells found com-

[1]For a complete analysis of Hundred foot oil from the Plum Creek Church pool in Plum township, see M. E. Johnson, Mineral resources of the Greensburg quadrangle; Pennsylvania Top. & Geol. Survey Atlas of Pennsylvania No. 37, p. 117, 1925.

mercial production and all have been abandoned for many years. None of the wells produced over 15 or 20 barrels a day at any time.

In 1917 oil was found in the Fifth sand at Glassport. Several wells were drilled but none of them obtained more than 5 or 10 barrels of oil a day. In 1920 other wells just east of Glassport found both oil and gas in the same (the Fifth) sand, but the production there also was small. In 1925 one well in Glassport was still producing two barrels of oil a day.

The Carnegie Natural Gas Company found a show of oil in the Hundred-foot sand in a well drilled on the John A. Boyd farm, near Linhart, in 1917. This show of oil led the Linhart Oil & Gas Company to drill just a little farther up the valley of Chalfont Run and they were rewarded by getting a well with an initial production of 16 barrels of oil a day. Other companies hastened to drill wells, only to find the pool practically exhausted by the Linhart well.

The Carnegie Natural Gas Company also obtained oil in a well drilled in 1916 on the John Munhall estate, in the valley of Whitaker Run and a little over a mile south of Monongahela River. Oil was obtained from the Fifth sand and was still being pumped in commercial quantities in the summer of 1925. Other wells in the vicinity produced gas or were dry.

Influence of Structure on the location of oil pools

At first glance structure seems to have played little part in the location of the oil pools in this quadrangle. But certainly it is more than a coincidence that the West Elizabeth oil pool is located almost on the crest of the Murrysville anticline; and that the Carnegie well in the valley of Whitaker Run and the small pools near Sandy Creek are almost on the crest of the Amity anticline. Moreover the biggest part of the Unity Station pool is on a broad nose projecting into the Duquesne syncline, and the Linhart pool is on another and more pronounced nose into the same syncline. The structure in the vicinity of the Wilmerding pool is too flat to be accurately mapped by the use of a barometer and Locke level; but without a doubt, accurate mapping would show a terrace or other structure to account for the occurrence of oil there. The location of the Glassport pool remains unexplained. Yet it may be that structure can account for that too; for there is a slight upward roll in the structure a quarter of a mile south of B. M. 1094 that may link the two pools. This upward roll can be noted by walking along the outcrop of the Pittsburgh coal from B. M. 1094 around to the Portvue-Lincoln township line. It is so slight however that it scarcely shows on the structure map.

An interesting point relative to the location of the oil pools is that every one of them is either in the Duquesne syncline, or on that side

of the Amity and Murrysville anticlines which borders the Duquesne syncline. The obvious deduction would seem to be that the Duquesne syncline has been the source of all the oil found in the quadrangle.

Future development and production.

Little hope is entertained of finding any other commercially important oil pools. The Pittsburgh quadrangle has been so thoroughly tested by drill-holes that it is almost certain no oil pools as much as a square mile in area remain undiscovered. Deep drilling does not offer any hope in this respect either, as oil is not believed to occur below the Speechley sand in this region.

It is doubtful if the total production of all the oil wells still being pumped in 1925 would exceed 15 barrels a day. Some of the wells are being pumped every day, others only once or twice a week. The decline in production is very slow however, and unless the price of oil drops below $3 a barrel, in all probability a few wells will still be pumping ten, or maybe fifteen, years from now. Compared with the flush production of some of the big western fields, the production of oil in this quadrangle seems altogether negligible; yet a simple arithmetical calculation will show that since oil was first produced in the quadrangle, over a million dollars' worth has been taken from the ground (assuming an average price of $2 a barrel for the oil and a total average daily production of only 45 barrels).

Selected Drill Records

Property name and owner of well		W. J. T. Saint American Nat. Gas Co.	Highland Park Chartiers Valley Gas Co.	Hartman Lincoln O. & G. Co.	James Finley Blaine McKee	Dillworth McCalmont Oil Co.	John H. Ward McKeesport-Versailles O. & G. Co.	Wallace Edgewood Oil & Gas	Thompson Fern Hollow O. & G. #1
Location of well		Shaler twp.	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Wilkinsburg	Wilkinsburg	Pittsburgh
Well number on map		1	2	3	4	5	6	7	8
Elevation of well mouth		975	±1,020	±1,015	882	885	978	850	772
Base of Pittsburgh coal		+205	+135	+135	+270	+275	+177	+305	+370
Salt sand	T								
	B								
Mauch Chunk red shale	T								
	B								
Big Lime	T								
	B								
Big Injun sand	T	1,050	1,006	1,013		930	945	890	800
	B	1,260	1,370	1,353		1,420	1,400	1,175	1,100
Squaw sand	T	1,320						1,270	1,160
	B	1,400						1,360	1,275
Berea sand	T					1,485		1,468	1,405
	B					1,510		1,520	1,450
Murrysville sand	T	1,592	1,720	1,738	1,575		1,660	1,578	1,495
	B	1,700	1,822	1,828	1,690		1,770		
Hundred-foot sand: Gantz	T	1,732	1,827	1,888	1,717		1,797		
	B	1,853	1,963	1,978	1,818		1,910		
Hundred-foot sand: Fifty-foot	T								
	B								
Thirty-foot sand	T	1,880					1,920		
	B	1,936					1,965		
Snee sand	T	1,960	2,009	2,030			1,975		
	B	2,040	2,093	2,065			1,997		
Catskill red beds	T								
	B								
Boulder sand	T		2,094						
	B		2,126						
Third sand	T	2,050		2,110	1,970		2,065		
	B	2,075		2,150	1,980		2,085		
Fourth sand	T	2,085	2,192	2,160			2,130		
	B	2,125	2,230	2,195			2,140		
Fifth sand	T	2,135	2,280	2,230	2,128		2,170		
	B	2,150	2,306	2,240	2,153		2,197		
Sixth sand	T			2,270		2,135	2,225		
	B			2,290		2,145	2,240		

Selected Drill Records

Carnegie Tech. Carnegie Tech.	Morehead & Co. Morehead & Co.	Boyd's Hill Dr. Hunter	Amer Iron & Steel Works #1 Jones & Laughlin	Amer. Iron & Steel Works #2 Jones & Laughlin	Hays Heirs #3 South Hills O. & G.	Stella Hays #3 South Hills O. & G. Co.	John Sello #1 South Hills O. & G. Co.	Bughman #1 South Hills O. & G. Co.	Sankey #1 South Hills O. & G. Co.	Wm. Bennett #1 South Hills O. & G. Co.	Willock #2 South Hills O. & G. Co.
Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	St. Clair Boro.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.
9	10	11	12	13	14	15	16	17	18	19	20
920	730	865	745	730	765	897	1,130	1,207	1,170	1,168	1,195
+170	+315	+180	+320	+320	+280	+133	—114	—126	—140	—172	—196
725 780	595 654	729 994	595 825	605 812	630 700	770 970	990 1,125	1,010 1,190	1,030 1,210	1,050 1,213	1,090 1,155
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	840 850	-------- --------	825 853	835 840	-------- --------	-------- --------	-------- --------	1,310 1,360	1,330 1,380	-------- --------	-------- --------
-------- --------	850 1,055	1,076 1,186	945 1,295	935 1,105	865 1,002	1,010 1,240	1,225 1,460	1,360 1,580	1,380 1,600	1,330 1,585	1,363 1,625
-------- --------	1,210 1,290	1,340 1,375	-------- --------	1,220 1,290	1,266 1,326	-------- --------	-------- --------	1,655 1,750	1,675 1,770	1,625 1,795	1,680 1,695
-------- --------	1,430 1,450	1,590 1,700	1,425 1,450	1,415 1,511	1,460 1,508	1,580 1,615	1,830 1,920	1,868 1,913	1.888 1,933	1,890 1,935	1,919 1,940
1,655 1,745	1,530 1,560	1,700 1,775	1,525 1,618	1,511 1,660	1,545 1,650	1,691 1,770	1,960 2,025	1,955 2,005	1,975 2,055	2,000 2,080	2.037 2,145
1,800 1,870 -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	1,643 1,720 -------- --------	1,660 1,717 1,717 1,724	1,703 1,749 1,753 1,778	1,812 1,914 -------- --------	2,058 2,143 2,143 2,165	2,140 2,230 -------- --------	2,090 -------- -------- --------	2,131 2,181 -------- --------	2,185 2,270 -------- --------
1,885 1,915	-------- --------	-------- --------	1,798 1,805	1,780 1,797	1,830 1,844	1,965 1,995	2,204 2,212	-------- --------	-------- --------	2,267 2,303	2,320 2,348
1,940 1,990	-------- --------	1,950 1,965	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,280 2,316	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	1,880 1,890	-------- --------	-------- --------	-------- --------	2,237 2,294	-------- --------	2,300 2,305	-------- --------	-------- --------
-------- --------	1,875 1,900	2,010 2,050	1,860 1,868	-------- --------	-------- --------	2,035 2,040	2,294 2,303	2,316 2,330	2.340 2,350	2,360 2,370	2,404 2,414
2,055 2.100	-------- --------	-------- --------	1,915 1,979	-------- --------	1,924 1,932	2,085 2,105	-------- --------	2,345 2,356	2,372 2,385	2,392 2,399	-------- --------
2,120 2,135	-------- --------	2,090 2,138	1,979 1,986	-------- --------	2,006 2,028	2,142 2,152	2,375 2,384	2,375 2,385	2,402 2,436	2,440 2,450	2,463 2,512
-------- --------	-------- --------	-------- --------	2,025 2,034	-------- --------	-------- --------	-------- --------	2,445 2,452	2,453 2,468	2,321 2,522	2,502 2,536	2,548 2,582
2,285 2,335	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2.560 2,564	-------- --------	-------- --------	2,631 2,633	-------- --------

Selected Drill Records

Property name and owner of well		W. J. T. Saint American Nat. Gas Co.	Highland Park Chartiers Valley Gas Co.	Hartman Lincoln O. & G. Co.	James Finley Blaine McKee	Dillworth McCalmont Oil Co.	John H. Ward McKeesport-Versailles O. & G. Co.	Wallace Edgewood Oil & Gas	Thompson Fern Hollow O. & G. #1
Location of well		Shaler twp.	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Wilkinsburg	Wilkinsburg	Pittsburgh
Elizabeth sand	T								
	B								
First Speechley or Speechley Stray sand	T						3,040		
	B						3,070		
Speechley sand	T		3,150		2,953	2,966			
	B				2,965	2,986			
Tiona sand	T						3,200		
	B						3,215		
Sheffield sand	T								
	B								
Bradford sand	T								
	B								
Total depth		2,151	3,933	2,493½	3,075	4,618	3,840	3,066	
Producing sand		Dry	Dry	Snee	Mur. Sp.		Mur.	Squaw?	B. I. Mur.
Initial production				20,000	55,000				2,000,000

Selected Drill Records

Carnegie Tech. Carnegie Tech.	Morehead & Co. Morehead & Co.	Boyd's Hill Dr. Hunter	Amer. Iron & Steel Works #1 Jones & Laughlin	Amer. Iron & Steel Works #2 Jones & Laughlin	Hays Heirs #3 South Hills O. & G. Co.	Stella Hays #3 South Hills O. & G. Co.	John Sello #1 South Hills O. & G. Co.	Bughman #1 South Hills O. & G. Co.	Sankey #1 South Hills O. & G. Co.	Wm. Bennett #1 South Hills O. & G. Co.	Willock #2 South Hills O. & G. Co.
Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	Pittsburgh	St. Clair Boro.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.
							2,587		2,611		
							2,600		2,613		
3,075							3,263				3,387
3,130							3,269				3,391
3,730											
3,734											
			3,000		2,031	2,164			2,642	2,637½	3,404
100' 6th	B. I. oil g. s.	oil-Mur	30'	100'	Fourth	Fifth Gantz	Berea Speechley	Mur. 5th	30' 4th Eliz.	4th	Mur. 30'—5th Speechley
250,000								400,000	50,000		

Selected Drill Records

Property name and owner of well		Nicholas Olringer South Hills O. & G. Co.	Dupont & Haskell South Hills O. & G. Co.	Willock Hrs. #3 South Hills O. & G. Co.	J. I. Wallace #1 South Hills O. & G. Co.	Moore Heirs South Hills O. & G. Co.	G. & J. Cale #1 Mft. Light & Heat Co.	S. W. Linhart South Hills O. & G. Co.	David Walker Hrs. Mft. Light & Heat Co.
Location of well		Baldwin twp.	Baldwin twp.	Mifflin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.
Well number on map		21	22	23	24	25	26	27	28
Elevation of well mouth		1,155	1,075	±1,150	1,212	1,240	1,180	1,220	±1,225
Base of Pittsburgh coal		—126	—68	—152	—262	—276	±930	—276	—270
Salt sand	T	1,055	1,025	1,112	1,195	1,205	----	1,205	----
	B	1,180	1,140	1,205	1,330	1,342	----	----	----
Mauch Chunk red shale	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Big Lime	T	----	----	----	----	----	----	----	1,420
	B	----	----	----	----	----	----	----	1,450
Big Injun sand	T	1,285	1,220	1,345	1,405	1,420	----	1,460	1,450
	B	1,700	1,525	1,634	1,710	1,720	----	1,720	1,725
Squaw sand	T	----	1,600	1,760	----	1,783	----	1,800	1,800
	B	----	1,640	1,790	----	1,887	----	1,830	1,805
Berea sand	T	1,858	1,798	----	1,990	2,008	----	2,010	2,035
	B	1,890	1,825	----	2,020	2,043	----	2,035	2,070
Murrysville sand	T	1,965	1,910	2,000	2,075	2,090	----	2,108	----
	B	2,000	2,040	2,085	2,175	2,180	----	2,135	----
Hundred-foot sand { Gantz	T	2,125	2,085	2,147	2,227	2,242	2,190	2,227	2,242
	B	2,210	2,137	2,207	2,292	2,352	----	2,290	2,322
Fifty-foot	T	----	2,150	----	----	----	2,225	2,293	----
	B	----	2,165	----	----	----	2,243	2,311	----
Thirty-foot sand	T	2,250	----	----	2,365	2,379	2,340	2,380	2,361
	B	2,283	----	----	2,400	2,414	----	2,410	2,401
Snee sand	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Catskill red beds	T	----	2,335	----	----	----	----	----	----
	B	----	2,375	----	----	----	----	----	----
Boulder sand	T	2,290	2,216	2,305	2,453	2,442	----	2,460	2,460
	B	2,310	2,245	2,327	2,473	2,452	----	2,550	2,470
Third sand	T	2,330	2,288	2,377	2,508	2,461	2,470	----	2,510
	B	2,340	2,300	2,386	2,523	2,480	2,486	----	2,530
Fourth sand	T	2,390	2,377	2,450	----	2,517	----	2,550	2,565
	B	2,400	2,389	2,463	----	2,550	----	2,562	2,570
Fifth sand	T	2,465	2,431	2,520	2,598	2,596	----	2,600	2,605
	B	2,500	2,472	2,553	2,634	2,646	----	2,649	2,635
Sixth sand	T	----	----	----	2,726	2,734	2,688	2,460	2,740
	B	----	----	----	2,727	2,737	2,690	2,490	2,745

Selected Drill Records

Johnson Wilson Mft. Light & Heat Co.	Eli McElheny Mft. Light & Heat Co.	McElheny #1 Mft. Light & Heat Co.	Cochran Philadelphia Co.	Wallace #3 Ed. Beedle	Wallace #4 Ed. Beedle	Wallace #2 Ed. Beedle	Wallace #1 Ed. Beedle	Galliford #1 Ed. Beedle	Jos. Walton Farm Beedle & Samuels	Weatherspoon Well Floreffe Oil & Gas Co.	Wm. Tweedy Hrs. Peoples Nat. Gas. Co.
Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.
29	30	31	32	33	34	35	36	37	38	39	40
1,167	1,003	933	+965	1,053	995	900	984	995	780	983	800
—190	+6	+77	+75	—5	+50	+150	+50	+40	+140	—45	200
-------- --------	-------- --------	840 --------	848 903	964 1,004	905 940	773 --------	848 --------	892 948	-------- --------	955 --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	1,190 --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	1,205 --------	-------- --------
-------- --------	-------- --------	-------- --------	1,123 1,408	-------- --------	1,100 1,400	-------- --------	-------- --------	1,200 1,500	1,090 1,385	1,285 1,560	995 1,318
-------- --------	-------- --------	-------- --------	1,518 1,543	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	1,603 --------	---------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- 2,145	-------- 2,010	-------- 1,910	1,903 1,953	-------- --------	1,910 1,960	-------- --------	-------- --------	1,925 1,990	-------- --------	2,010 --------	-------- --------
-------- --------	-------- --------	-------- --------	1.963 1,988	-------- --------	1,970 2.000	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- -------- -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	2,018 2,068 2,073 2,078	-------- -------- -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	-------- -------- -------- --------	2,160 2,190 -------- --------	1,840 1,930 -------- --------
-------- --------	-------- --------	-------- --------	2,068 2,288	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,200 2,245	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,245 --------	-------- --------
-------- --------	-------- --------	-------- --------	2,168 2,188	-------- --------	2,220 2,250	-------- --------	-------- --------	-------- --------	2,102 2,133	2,290 --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,280 2,300	-------- --------	-------- --------	-------- --------	2,205 2,234	-------- --------	-------- --------
-------- 2,555	-------- --------	-------- --------	-------- --------	-------- --------	2,350 2,370	-------- --------	-------- --------	-------- --------	2,249 2,306	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,400 2,410	-------- --------	-------- --------	-------- --------	-------- --------	2,460 2,490	2,228 2,243

Selected Drill Records

Property name and owner of well		Nicholas Olringer South Hills O. & G. Co.	Dupont & Haskell South Hills O. & G. Co.	Willock Hrs. #3 South Hills O. & G. Co.	J. L. Wallace #1 South Hills O. & G. Co.	Moore Heirs South Hills O. & G. Co.	G. & J. Cale #1 Mft. Light & Heat Co.	S. W. Linhart South Hills O. & G. Co.	David Walker Hrs. Mft. Light & Heat Co.
Location of well		Baldwin twp.	Baldwin twp.	Mifflin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.	Baldwin twp.
Elizabeth sand	T B					2,756 2,758		2,828 2,847	
First Speechley or Speechely Stray sand	T B								
Speechley sand	T B	3,303 3,318			3,443 3,453	3,454 3,464			3,400 3,464
Tiona sand	T B								
Sheffield sand	T B								
Bradford sand	T B								
Total depth		4,025	2,477	2,558½	3,463	3,499	2,705	3,490	3,496
Producing sands		5th Sp.	Gantz 50	Gantz 5th	Sp.	5th Eliz.	3rd 6th	Gantz 5th	Gantz Sp.
Initial production									

Selected Drill Records

Johnson Wilson Mft. Light & Heat Co.	Eli McElheny Mft. Light & Heat Co.	McElheny #1 Mft. Light & Heat Co.	Cochran Philadelphia Co.	Wallace #3 Ed. Beedle	Wallace #4 Ed. Beedle	Wallace #2 Ed. Beedle	Wallace #1 Ed. Beedle	Galliford #1 Ed. Beedle	Jos. Walton Farm Beedle & Samuels	Weatherspoon Well Floreffe Oil & Gas Co.	Wm. Tweedy Hrs. Peoples Nat. Gas Co.
Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Snowden twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.
------	------	------	------	------	------	------	------	------	2,420	2,560	2,346
------	------	------	------	------	------	------	------	------	------	------	2,368
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	3,145	------	------
------	------	------	------	------	------	------	------	------	3,165	------	------
------	------	------	------	------	------	------	------	------	3,305	------	------
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	------	------	------
------	------	------	------	------	------	------	------	------	------	------	------
2,874	2,563	1,950	2,348	------	2,450	820	886	1,990	3,367	------	2,395'6"
5th	50'	50'	3rd?	Salt	Gantz		Salt?	50'	1st Sp?	Eliz.	B. I.
				5 to 600,000							

Selected Drill Records

Property name and owner of well		Austen L. Nolder Virginia Gas & Oil Co.	Wm. Reed Peoples Nat. Gas Co.	Bedell, Wm. Forest Oil Co.	Theo. Large Six-Forty O. & G. Co.	Wm. Munhall	John Stilley Mft. Light & Heat Co.	Louisa Wilson Carnegie Nat. Gas Co.	Torrence Heirs **Mft. Light & Heat Co.**
Location of well		Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.
Well number on map		41	42	43	44	45	46	47	48
Elevation of well mouth		930	995	775	945	805	1,118	±990	1,192
Base of Pittsburgh coal		+70	+30	+130	+10	+135	−70	−25	−174
Salt sand	T			790	940	765	900	910	1,100
	B			885		810–970	1,045	1,093	1,150
Mauch Chunk red shale	T			1,030					
	B			1,050					
Big Lime	T			1,050	1,174			1,170	1,320
	B			1,100				1,202	1,365
Big Injun sand	T			1,100	1,224	1,020	1,250	1,202	1,365
	B			1,410		1,300	1,556	1,440	1,635
Squaw sand	T			1,470		1,443		1,547	
	B			1,485		1,463		1,639	
Berea sand	T								1,930
	B								1,950
Murrysville sand	T			1,735	1,826				
	B			1,760					
Hundred-foot sand { Gantz	T			1,870		1,822	2,040	1,996	2,124
	B			1,956		1,837	2,140	2,077	2,142
Hundred-foot sand { Fifty-foot	T					1,939			2,165
	B					1,942			2,186
Thirty-foot sand	T			1,986			2,185	2,131	
	B			1,993			2,205	2,161	
Snee sand	T			2,066					2,350
	B			2,096					2,370
Catskill red beds	T			1,993					
	B			2,242?					
Boulder sand	T				2,200		2,270	2,219	2,380
	B						2,310	2,233	2,410
Third sand	T			2,126				2,243	2,443
	B			2,152				2,310	2,485
Fourth sand	T			2,182			2,400		2,496
	B			2,207			2,420		2,522
Fifth sand	T		2,384	2,252			2,435	2,370	
	B		2,409	2,257			2,450	2,396	
Sixth sand	T			2,282			2,545	2,495	2,642
	B			2,297			2,551	2,500	2,647

Selected Drill Records

John N. Mowry Mit. Light & Heat Co.	John Stilley Peoples Nat. Gas Co.	Elizabeth P. Gordon Peoples Nat. Gas Co.	Andrew & Ida Marshall Peoples Nat. Gas Co.	John R. Walters Peoples Nat. Gas Co.	Forsythe #2 Philadelphia Co. #379	F. & K. Eckert Peoples Nat. Gas Co.	Pat Wilson Carnegie Nat. Gas Co.	Knots Carnegie Nat. Gas Co.	F. J. Kinney South Hills O. & G. Co.	Henry Risher Versailles Gas & Fuel Co.	Robert Brierly Carnegie Nat. Gas Co.
Jefferson twp.	Jefferson twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Hays Boro.	Mifflin twp.
49	50	51	52	53	54	55	56	57	58	59	60
1,177	1,020	1,165	-------	1,120	1,050	1,210	1,215	1,080	1,080	±1,045	1,142
—167	+5	—135	—115?	—110	—65	193	—204	—54	—66	+15	—110
------- -------	------- -------	------- -------	------- -------	1,080 1,165	1,000 1,100	------- -------	1,095 1,250	------- -------	1,000 1,095 (1,120)	------- -------	1,000 1,120
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	1,200 1,220	------- -------
------- -------	------- -------	------- -------	------- -------	1,300 1,610	1,210 1,570	1,370 1,670	1,380 1,670	1,240 1,550	1,250 1,420	1,220 1,345	1,265 1,445
------- -------	------- -------	------- -------	------- -------	1,660 1,915	1,585 1,725	------- -------	1,700 1,855	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	1,820 1,880	------- -------	1,937 2,014	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	1,978 2,055	1,895 2,060	------- -------	2,032 2,144	1,965 2,019	1,920 2,020	1,855 1,960	2,000 2,085
2,135 2,230	------- -------	------- -------	------- -------	2,100 2,195	2,075 2,145	2,200 2,367	2,191 2,306	2,030 2,130	2,040 2,130	1,980 2,071	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	2,225 2,250	2,165 2,175	------- -------	2,306 2,316	2,205 2,225	2,150 2,180	------- -------	2,240 2,290
------- -------	------- -------	------- -------	------- -------	2,265 2,312	2,250 2,270	------- -------	2,355 2,390	------- -------	------- -------	2,151 2,176	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	2,175 2,370	------- -------	2,390 2,540	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	2,420 2,455	------- -------	2,219 2,259	2,176 2,196	------- -------
2,430 2,450	------- -------	------- -------	2,369 2,404	2,350 2,445	------- -------	------- -------	2,465 2,475	------- -------	2,355 2,367	2,240 2,249	2,315 2,350
------- -------	2,277 2,313	2,435 2,465	------- -------	------- -------	2,370 2,410	2,506 2,524	2,490 2,520	------- -------	2,373 2,383	2,272 2,334	------- -------
2,513 2,532	2,353 2,400	2,500 2,560	2,477 2,495	2,505 2,524	------- -------	2,566 2,604	2,503 2,597	2,425 2,463	2,436 2,471	2,370 2,410	2,520 2,570
------- -------	------- -------	------- -------	------- -------	------- -------	2,438 2,513	------- -------	2,683 2,693	------- -------	2,472 2,477	------- -------	------- -------

Selected Drill Records

Property name and owner of well		Austen L. Nolder Virginia Gas & Oil Co.	Wm. Reed Peoples Nat. Gas Co.	Bedell, Wm. Forest Oil Co.	Theo. Large Six-forty O. & G. Co.	Wm. Munhall	John Stilley Mft. Light & Heat Co.	Louisa Wilson Carnegie Nat. Gas Co.	Torrence Heirs Mft. Light & Heat Co.
Location of well		Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.	Jefferson twp.
Elizabeth sand	T	2,476	2,522	2,397					
	B	2,497	2,545	2,400					
First Speechley or Speechley Stray sand	T								
	B								
Speechley sand	T			3,150					
	B			3,165					
Tiona sand	T								
	B								
Sheffield sand	T			3,500					
	B			3,520					
Bradford sand	T								
	B								
Total depth				5,705?		2,014	2,561	2,548	2,800
Producing sand		Eliz.	Eliz.	6th		Salt	6th	Gantz	B. I. 6th
Initial production		100,000			400,000				

Selected Drill Records

John N. Mowry Mft. Light & Heat Co.	John Stilley Peoples Nat. Gas Co.	Elizabeth P. Gordon Peoples Nat. Gas Co.	Andrew & Ida Marshall Peoples Nat. Gas Co.	John R. Walters Peoples Nat. Gas Co.	Forsythe #2 Philadelphia Co. #379	F. & K. Eckert Peoples Nat. Gas Co.	Pat Wilson Carnegie Nat. Gas Co.	Knots Carnegie Nat. Gas Co.	F. J. Kinney South Hills O. & G. Co.	Henry Risher Versailles Gas & Fuel Co.	Robert Brierly Carnegie Nat. Gas Co.
Jefferson twp.	Jefferson twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Hays Boro.	Mifflin twp.
-------- --------	2,494 2,507	2,656 2,660	-------- --------	2,622 2,639	-------- --------	2,711 2,717	-------- --------	2,555 2,562	2,585 2,587	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,215 3,230	3,262 3,266	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,343 3,345	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,855 3,870	-------- --------	-------- --------	-------- --------
--------	--------	2,726	2,637	2,653 B. I.	--------	2,758	2,739	3,920	3,375	2,569	3,390
3rd 5th	Eliz?	4th 5th Eliz.	5th Salt	B. I. Mur., 100', 3rd, 5th	B. I. 4th	B. I. 100'	6th	Eliz.	5th	5th	Mur. 5th
--------	--------	57,000	--------	149,030	--------	249,964	--------	--------	--------	159,000	38,000

Selected Drill Records

Property name and owner of well		Monongahela Southern Realty Co. Carnegie Nat. Gas Co.	Wm. E. Reed #60 Carnegie Nat. Gas Co.	L. B. Hays #3 Carnegie Nat. Gas Co.	L. B. Hays #14 Carnegie Nat. Gas Co.	Sarah Cox Philadelphia Co. #439	Herman Freudel Carnegie Nat. Gas Co.	Adolph Doer Carnegie Nat. Gas Co.	D. K. Calhoun #228 Philadelphia Co. #442
Location of well		Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.
Well number on map		61	62	63	64	65	66	67	68
Elevation of well mouth		±1,055	1,065	1,043	1,030	990	±1,065	1,076.1	1,035
Base of Pittsburgh coal		—18	—31	—15	—15	+50	+0	+9	+40
Salt sand	T	967	-------	-------	940	855	930	-------	-------
	B	1,090	-------	-------	1,060	955	1,080	-------	-------
Mauch Chunk red shale	T	-------	-------	-------	-------	1,050	-------	-------	-------
	B	-------	-------	-------	-------	1,095	-------	-------	-------
Big Lime	T	1,200	1,222	-------	1,170	1,095	1,120	1,145	1,107
	B	1,225	1,272	-------	1,195	1,130	1,160	1,170	1,143
Big Injun sand	T	1,225	1,272	1,200	1,200	1,135	1,160	-------	1,143
	B	1,740	1,600	1,315	1,540	1,460	1,440	-------	1,467
Squaw sand	T	-------	-------	-------	1,580	1,520	-------	-------	1,525
	B	-------	-------	-------	1,600	1,620	-------	-------	1,605
Berea sand	T	-------	-------	-------	-------	-------	-------	-------	1,730
	B	-------	-------	-------	-------	-------	-------	-------	1,769
Murrysville sand	T	1,900	1,900	-------	1,880	1,835	1,865	1,865	1,819
	B	2,025	2,000	-------	1,990	1,925	1,945	1,970	1,922
Hundred-foot sand: Gantz	T	-------	2,037	1,975	2,015	1,943	1,985	1,995	1,947
	B	-------	2,151	2,030	2,040	2,055	2,095	2,100	2,060
Hundred-foot sand: Fifty-foot	T	2,060	-------	-------	-------	-------	-------	-------	-------
	B	2,173	-------	-------	-------	-------	-------	-------	-------
Thirty-foot sand	T	-------	2,200	-------	2,065	2,065	-------	-------	2,070
	B	-------	2,235	-------	2,125	2,096	-------	-------	2,104
Snee sand	T	-------	-------	2,200	-------	-------	2,165	2,178	-------
	B	-------	-------	2,220	-------	-------	2,185	2,210	-------
Catskill red beds	T	-------	-------	-------	-------	-------	-------	-------	2,155
	B	-------	-------	-------	-------	-------	-------	-------	2,163
Boulder sand	T	-------	-------	-------	2,225	2,110	-------	2,220	2,120
	B	-------	-------	-------	2,273	2,155	-------	2,235	2,155
Third sand	T	2,210	-------	-------	2,300	2,240	2,260	2,260	2,163
	B	2,260	-------	-------	2,340	2,280	2,340	2,268	2,178
Fourth sand	T	2,345	2,358	2,340	2,360	2,280	-------	2,310	2,268
	B	2,355	2,395	2,380	2,384	2,295	-------	2,318	2,277
Fifth sand	T	2,375	2,443	2,420	2,417	2,340	2,365	2,394	2,347
	B	2,400	2,476	2,455	-------	2,375	2,405	2,434	2,385
Sixth sand	T	2,445	-------	-------	-------	-------	-------	-------	2,427
	B	2,481	-------	-------	-------	-------	-------	-------	2,441

Selected Drill Records

M. H. West Philadelphia Co. #644	John Munhall Estate #47 Carnegie Nat. Gas Co.	W. S. B. Hays Carnegie Nat. Gas Co.	John Munhall Estate #2 Carnegie Nat. Gas Co.	Carnegie Steel Co. (Homestead Steel Works) Carnegie Nat. Gas Co.	W. S. B. Hays #1 Carnegie Nat. Gas Co.	Satisfaction O. & G. Co.	John W. Milligan Est. Swissvale O. & G. Co.	Thos. C. Sandwehr American Nat. Gas Co.	Brown Limegrover	John Gerthofer W. F. Minter et al.	H. & A. M. Elliott Peoples Nat. Gas Co.
Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Homestead Boro.	Mifflin twp. Munhall Boro.	Swissvale Boro.	Swissvale Boro.	Penn twp.	Penn twp.	Penn twp.	Penn twp.
69	70	71	72	73	74	75	76	77	78	79	80
850	835	1,025	785	±760	760	910	1,075	1,079	1,255	1,185	1,162
240	+260	+60	+320	+340	345	+205	+40	+80	—75	—20	—4
673 792	-- --	-- --	600 660	-- --	-- --	720 865	895 1,085	-- --	-- --	-- --	-- --
895 900	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
910 925	-- --	1,120 1,130	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
925 1,265	890 1,265	1,130 1,435	950 1,190	820 1,100	-- --	945 1,270	1,118 1,435	1,100 1,300	-- --	1,200 1,500	1,130 1,590
1,305 1,395	-- --	1,480 1,600	-- --	-- --	-- --	1,305 1,465	1,460 1,630	-- --	-- --	-- --	1,600 1,765
1,515 1,573	-- --	-- --	-- --	-- --	-- --	1,555 1,600	1,745 1,800	1,700 1,720	1,865 --	1,835 1,900	1,790 1,860
1,620 1,739	1,620 1,722	-- --	-- --	-- --	-- --	1,670 1,750	1,830 1,928	1,778 1,876	1,940 --	1,910 1,985	1,860 1,975
1,760 1,916	1,747 1,865	1,915 2,065	1,690 1,790	1,642 1,742	1,635 1,735	1,770 1,875	1,955 --	1,905 2,015	2,065 --	2,008 2,100	2,000 2,092
-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
-- --	1,880 1,930	2,110 2,140	-- --	-- --	-- --	1,900 1,960	2,085 2,155	2,019 2,049	2,190 2,220	2,130 2,150	2,102 2,145
1,926 1,980	-- --	-- --	1,850 1,870	-- --	-- --	-- --	-- --	2,090 2,150	2,240 2,285	2,185 2,221	-- --
-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	2,221 2,237	-- --
-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	2,237 2,244	2,238 2,282
1,995 2,005	2,030 2,045	2,181 2,198	-- --	-- --	-- --	2,075 2,105	2,225 2,235	-- --	-- --	2,275 2,326	2,300 2,335
2,040 2,105	2,060 2,072	-- --	2,028 2,036	-- --	1,934 1,964	-- --	2,265 2,335	-- --	-- --	2,335 2,340	2,360 2,380
2,118 2,210	2,140 2,149	2,332 2,364	2,088 2,102	2,038 2,056	2,060 2,085	2,185 2,214	2,364 2,404	-- --	-- --	2,390 2,392	2,425 2,454
-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	2,460 2,462	-- --

Selected Drill Records

Property name and owner of well		Monongahela Southern Realty Co. Carnegie Nat. Gas Co.	Wm. E. Reed #60 Carnegie Nat. Gas Co.	L. B. Hays #3 Carnegie Nat. Gas Co.	L. B. Hays #14 Carnegie Nat. Gas Co.	Sarah Cox Philadelphia Co. #439	Herman Freudel Carnegie Nat. Gas Co.	Adolph Doer Carnegie Nat. Gas Co.	D. K. Calhoun #228 Philadelphia Co. #442
Location of well		Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.
Elizabeth sand	T	2,573	2,570	2,551				2,540	2,476
	B	2,593	2,579	2,555				2,541	2,484
First Speechley or Speechley Stray sand	T								
	B								
Speechley sand	T								
	B								
Tiona sand	T								
	B								
Sheffield sand	T								
	B								
Bradford sand	T								
	B								
Total depth		2,610	2,738	2,622	2,430	2,550	2,565	2,565	
Producing Sand				4th Eliz.	5th	5th			100′ 5th Eliz.
Inintial production									

Selected Drill Records

M. H. West Philadelphia Co. #644	John Munhall Estate #47 Carnegie Nat. Gas Co.	W. S. B. Hays Carnegie Nat. Gas Co.	John Munhall Estate #2 Carnegie Nat. Gas Co.	Carnegie Steel Co. (Homestead Steel Works) Carnegie Nat. Gas Co.	W. S. B. Hays #1 Carnegie Nat. Gas Co.	Satisfaction O. & G. Co.	John W. Milligan Est. Swissvale O. & G. Co.	Thos. C. Sandwehr American Nat. Gas. Co.	Brown Limegrover	John Gerthofer W. F. Minter et al.	H. & A. M. Elliott Peoples Nat. Gas Co.
Mifflin twp.	Mifflin twp.	Mifflin twp.	Mifflin twp.	Homestead Boro.	Mifflin twp. Munhall twp.	Swissvale Boro.	Swissvale Boro.	Penn twp.	Penn twp.	Penn twp.	Penn twp.
										2,590	
				2,870							
				2,873							
				3,541							
				3,546							
	2,151	2,552	3,970	3,645	2,100	3,680		2,202	2,519	2,610	2,478
100′ 5th	5th	100′ 5th	100′ 5th	100′ 5th	5th		5th	Berea Mur. 100′ Snee	100′ Snee	Berea Hund	Berea 5th

Selected Drill Records

Property name and owner of well		W. A. Kingan American Nat. Gas Co.	H. Duff Peoples Nat. Gas Co.	C. H. Duff American Nat. Gas Co.	Alex Duff Henry Chalfont #4	American Nat. Gas Co. American Nat. Gas Co.	Henry Chalfont #3 American Nat. Gas Co.	Math. Taylor Peoples Nat. Gas Co.	Robt. & Ralph Colins Peoples Nat. Gas Co.
Location of well		Penn twp.	Penn twp.	Penn twp.	Penn twp.	Wilkins twp.	Wilkins twp.	Penn twp.	Penn twp.
Well number on map		81	82	83	84	85	86	87	88
Elevation of well mouth		1,229	1,151	1,085	1,112	1,055	1,110	1,067	1,102
Base of Pittsburgh coal		—85	+3	+55	+15	+65	+7	+ 55	+25
Salt sand	T								
	B								
Mauch Chunk red shale	T	1,200				1,005			1,108
	B	1,255				1,130			1,118
Big Lime	T								1,118
	B								1,146
Big Injun sand	T	1,255	1,175	1,128	1,172	1,130	1,275	1,110	1,160
	B	1,600	1,495	1,443	1,510	1,390	1,500	1,370	1,510
Squaw sand	T		1,575				1,575		
	B		1,675				1,685		
Berea sand	T	1,890		1,732		1,730	1,760	1,720	
	B	1,920		1,767		1,770	1,800	1,750	
Murrysville sand	T	1,960	1,890	1,840	1,862	1,830	1,865	1,820	1,848
	B	2,045	1,970	1,933	1,964	1,920	1,963	1,920	1,954
Hundred-foot sand: Gantz	T	2,064		1,967	1,995	1,949	1,998	1,952	1,986
	B	2,120		2,066	2,105	2,059	2,120	2,022	2,083
Hundred-foot sand: Fifty-foot	T								
	B								
Thirty-foot sand	T	2,205			2,115	2,074		2,037	
	B	2,230			2,130	2,124		2,052	
Snee sand	T	2,240	2,170	2,126			2,170		
	B	2,280	2,210	2,156			2,205		
Catskill red beds	T								2,140
	B								2,165
Boulder sand	T		2,262	2,175			2,223		2,180
	B		2,340	2,187			2,233		2,205
Third sand	T	2,365		2,253			2,258	2,250	2,262
	B	2,435		2,288			2,270	2,255	2,272
Fourth sand	T			2,328		2,297		2,280	2,346
	B			2,343		2,332		2,302	
Fifth sand	T	2,494	2,460	2,370	2,418	2,362	2,418	2,380	2,425
	B	2,518	2,490	2,395	2,440	2,393	2,438	2,407	2,455
Sixth sand	T								
	B								

Selected Drill Records

John L. Rosemeyer T. W. Phillips	Harry Stotler Peoples Nat. Gas Co. #883	H. W. Hershey #1 Peoples Nat. Gas Co.	Robt. McConnell T. W. Phillips	Simon Vetter South Penn Oil	Pahlman Hrs. American Nat. Gas Co.	Margaret E. Stotler American Nat. Gas Co.	W. F. Craig Peoples Nat. Gas Co.	E. G. Stotler #1 Peoples Nat. Gas Co.	J. K. Musgrave T. W. Phillips	J. J. Buchanan T. W. Phillips	Geo. H. McLaughlin T. W. Phillips
Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Plum twp.	Plum twp.
89	90	91	92	93	94	95	96	97	98	99	100
1,150	995	1,100	1,065	1,014	1,120	1,110	1,090	1,185	995	1,060	1,015
—30	+140	+35	+90	+225	+70	+85	+75	—45	+170	+100	+150
		910 990									
					895? 1,050	1,040 1,065					
					1,050 1,095	1,065 1,080					
1,185	1,110 1,295				1,095 1,406	1,097 1,440	1,130 1,455				1,015 1,370
	1,295 1,385						1,500 1,545				
						1,690 1,730	1,765 1,773				
1,920	1,751 1,831	1,836 1,946	1,780 1,890		1,780 1,889		1,838 1,922	1,910 2,012		1,924	
2,027	1,875 1,983	2,010 2,090	1,900 1,980	1,763 1,860	1,916 2,006	1,770 1,872 1,910 2,027	1,950 2,024	2,046 2,122	1,835 1,930		1,845 1,950
			2,020 2,050				2,039 2,090	2,166 2,187	1,960 2,000		1,905 2,025
2,200	2,053 2,080		2,080 2,110		2,110 2,137	2,103 2,148			2,000 2,045	2,075 2,100	
					2,006 2,260						
2,225	2,107 2,119					2,158 2,198			2,045 2,060		2,040 2,080
2,325	2,142 2,157								2,088 2,100		
2,325	2,185 2,200		2,270 2,300		2,270 2,323		2,265 2,332		2,180 2,210	2,234	2,180 2,235
2,444	2,295 2,318	2,399 2,436	2,340 2,370		2,353 2,378	2,343 2,371	2,370 2,393	2,477 2,508	2,272 2,302	2,351	2,288 2,320
								2,544 2,552			

Selected Drill Records

Property name and owner of well		W. A. Kingan American Nat. Gas Co.	H. Duff Peoples Nat. Gas Co.	C. H. Duff American Nat. Gas Co.	Alex Duff American Nat. Gas Co.	Henry Chalfont #4 American Nat. Gas Co.	Henry Chalfont #3 American Nat. Gas Co.	Math. Taylor Peoples Nat. Gas Co.	Robt. & Ralph Colins Peoples Nat. Gas Co.
Location of well		Penn twp.	Penn twp.	Penn twp.	Penn twp.	Wilkins twp.	Wilkins twp.	Penn twp.	Penn twp.
Elizabeth sand	T				2,555				
	B								
First Speechley or Speechley Stray sand	T								3,104
	B								3,130
Speechley sand	T								
	B								
Tiona sand	T								
	B								
Sheffield sand	T							3,520	
	B							3,536	
Bradford sand	T								3,805
	B								3,825
Total depth			2,545	2,575?	2,603	2,393	2,578		4.017
Producing sand		5th	301? Snee?	100′	100′ Eliz.	5th 100′	5th		
Initial production									

Selected Drill Records

John L. Rosemeyer T. W. Phillips	Harry Stotler Peoples Nat. Gas Co. #883	H. W. Hershey #1 Peoples Nat. Gas Co.	Robt. McConnell T. W. Phillips	Simon Vetter South Penn Oil	Pahlman Hrs. American Nat. Gas Co.	Margaret E. Stotler American Nat. Gas Co.	W. F. Craig Peoples Nat. Gas Co.	E. G. Stotler #1 Peoples Nat. Gas. Co.	J. K. Musgrave T. W. Phillips	J. J. Buchanan T. W. Phillips	G. H. McLaughlin T. W. Phillips
Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Penn twp.	Plum twp.	Plum twp.
2,554 --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,455 2,485	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,207 --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	3,265 3,272	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,265 3,275	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	3,460 3,465	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,633 3,645	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,860 3,876	3,858 3,870	-------- --------	-------- --------	-------- --------
3,350	2,318	3,525	2,700	2,227	2,564	--------	4,045	4,048	2,302	2,372	--------
B. I. 5th	B. I. Snee 5th	5th	100′ 5th	5th?	oil 100′ gas 5th	100′ 5th	100′ 4th 5th	6th Shef. Brad.	oil 100′ gas 5th	4th 5th	4th 5th
--------	--------	680,928	--------	--------	--------	--------	--------	--------	--------	--------	--------

Selected Drill Records

Property name and owner of well		Wm. & Sarah Jackson Peoples Nat. Gas Co.	Anna M. Kuhn Peoples Nat. Gas Co.	Lewis Ritter #1 Peoples Nat. Gas Co.	Wm. N. Clements American Nat. Gas Co.	L. S. Goehring American Nat. Gas Co.	Oliver & Rob't. Thompson Philadelphia Co. #472	C. B. Beatty Philadelphia Co.	Dan'l McMaster American Nat. Gas Co.
Location of well		Plum twp.	Plum twp.	Plum twp.	Plum twp.	Plum twp.	Patton twp.	Patton twp.	Patton twp.
Well number on map		101	102	103	104	105	106	107	108
Elevation of well mouth		985	975	1,120	1,120	1,030	1,190	1,152	1,140
Base of Pittsburgh coal		+190	+225	+75	+65	+135	—25	+35	+70
Salt sand	T								
	B								
Mauch Chunk red shale	T								
	B								
Big Lime	T								
	B								
Big Injun sand	T	1,105	960	1,095	1,220		1,195		1,130
	B	1,340	1,270	1,335	1,470		1,625		1,527
Squaw sand	T			1,350					
	B			1,540					
Berea sand	T					1,715?			1,748
	B					1,839			1,800
Murrysville sand	T	1,665	1,660	1,795	1,805		1,923	1,825	1,850
	B	1,785	1,775	1,918	1,888		2,021	1,925	1,960
Hundred-foot sand: Gantz	T	1,815	1,780	1,924	1,930	1,875	2,030	1,935	1,960
	B	1,940	1,900	2,030	2,030	1,930	2,125	3,035	2,070
Hundred-foot sand: Fifty-foot	T								
	B								
Thirty-foot sand	T			2,033	2,080	2.000	2,130		2,090
	B			2,055	2,110	2.025	2,190		2,119
Snee sand	T	2,015							2,175
	B	2,030							2,195
Catskill red beds	T						2,190		2,155
	B						2,478		2,436?
Boulder sand	T				2,175				2,220
	B				2,195				2,217
Third sand	T		2,100	2,245	2,262				2,255
	B		2,158	2,310	2,297				2,275
Fourth sand	T	2,175	2,165		2,305	2,270			2,345
	B	2,220	2,190		2,345	2,300			2,365

Selected Drill Records

Charles Kuehn Philadelphia Co.	C. J. Bailey Philadelphia Co. #473	Thos. Dunning Carnegie Nat. Gas Co. #75	Jos. Lovett Philadelphia Co. #912	Margaret McCully Peoples Nat. Gas Co.	John A. Boyd Carnegie Nat. Gas Co.	Monongahela Nat'l Bank Carnegie Nat. Gas Co.	Anna W. Gilmore Carnegie Nat. Gas Co.	Matilda J. Snyder Carnegie Nat. Gas Co.	Samuel B. Brown Carnegie Nat. Gas Co.	Carnegie Sand Co. Carnegie Nat. Gas Co.	Minteer & Craig Lot Minteer & Craig
Patton twp.	Patton twp.	Penn twp.	Penn twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	North Braddock	North Braddock
109	110	111	112	113	114	115	116	117	118	119	120
1,120	1,132	1,069	980	1,078	860	1,035	800	1,005	940	800	[illegible]85
+100	+5	+33	+100	+10	+227	+ 25	+265	+20	+75	+235	+115
843 915?		900 925								700 865	
											1,095
1,050 1,530		1,115 1,496		1,200 1,470	985 1,310	1,175 1,470	940 1,245	1,140 1,460	1,100 1,425	990 1,490	1,150 1,300
		1,506 1,620				1,480 1,660	1,260 1,410	1,500 1,660	1,460 1,620		
1,695 1,752		1,750 1,785		1,760 1,810	1,560 1,590	1,765 1,805	1,530 1,570	1,745 1,785	1,690 1,725		
1,780 1,920 1,945 2,005	1,880 1,990 2,015 2,061	1,840 -------- -------- 2,025		1,875 2,000 2,000 2,090	1,660 1,760 1,800 1,920	1,860 1,955 1,998 2,110	1,635 1,730 1,765 1,872	1,835 1,940 1,978 2,075	1,790 1,885 1,927 2,035	1,660 1,765 1,790 1,896	1,780 1,860 1,900 2,035
						2,150 2,200	1,915 1,965	2,130 2,150			2,050 2,080
2,090 2,160				2,180 2,210	1,970 2,010				2,095 2,140	1,935 1,965	2,110 2,120
2,160 2,285											
						2,235 2,250	1,995 2,010				2,140 2,150
						2,275 2,285	2,025 2,035				2,180 2,190
2,285 2,315		2,310 2,337		2,353 2,398	2,125 2,160	2,318 2,366	2,085 2,129	2,295 2,333	2,249 2,284	2,145 2,185	2,245 2,274

Selected Drill Records

Property name and owner of well		Wm. & Sarah Jackson Peoples Nat. Gas Co.	Anna M. Kuhn Peoples Nat. Gas Co.	Lewis Ritter #1 Peoples Nat. Gas Co.	Wm. N. Clements American Nat. Gas Co.	L. S. Goehring American Nat. Gas Co.	Oliver & Rob't. Thompson Philadelphia Co. #472	C. B. Beatty Philadelphia Co.	Dan'l McMaster American Nat. Gas Co.
Location of well		Plum twp.	Plum twp.	Plum twp.	Plum twp.	Plum twp.	Patton twp.	Patton twp.	Patton twp.
Fifth sand	T	2,260	2,205	2,361	2,350	2,305	2,478	--------	2,415
	B	2,300	2,240	2,384	2,400	2,330	2,518	--------	2,425
Sixth sand	T	--------	--------	--------	2,450	2,381	2,547	--------	2,436
	B	--------	--------	--------	2,455	2,396	2,562	--------	2,444
Elizabeth sand	T	2,360	2,310	--------	--------	--------	--------	2,516	2,488
	B	2,370	2,320	--------	--------	--------	--------	2,524	2,494
First Speechley or Speechley Stray sand	T	--------	--------	--------	--------	--------	--------	3,145	3,110
	B	--------	--------	--------	--------	--------	--------	3,160	3,190
Speechley sand	T	3,085	3,034	3,187	3,200	3,160	--------	--------	3,221
	B	3,103	3,070	3,223	3,220	3,180	--------	--------	3,230
Tiona sand	T	3,250	--------	--------	--------	3,260	--------	--------	--------
	B	3,260	--------	--------	--------	3,280	--------	--------	--------
Sheffield sand	T	--------	--------	--------	--------	3,430	--------	--------	--------
	B	--------	--------	--------	--------	3,436	--------	--------	--------
Bradford sand	T	3,720	--------	3,832	--------	3,758	--------	3,881	--------
	B	3,730	--------	3,860	--------	3,783	--------	3,900	--------
Total depth	---	3,776	3,079	3,871	3,220	3,806?	--------	3,919	3,531
Producing sand		oil 100' gas 5th Sp.	oil 100' gas 3rd Sp.	5th Sp. Brad.	Sp.	Brad.	30'	Eliz. Brad.	B. I. Eliz. Sp.
Initial production		--------	--------	--------	--------	--------	--------	--------	--------

Selected Drill Records

Charles Kuehn Philadelphia Co.	C. J. Bailey #473 Philadelphia Co.	Thos. Dunning Carnegie Nat. Gas Co. #75	Jos. Lovett #912 Philadelphia Co.	Margaret McCully Peoples Nat. Gas Co.	John A. Boyd Carnegie Nat. Gas Co.	Monongahela Nat'l Bank Carnegie Nat. Gas Co.	Anna W. Gilmore Carnegie Nat. Gas Co.	Matilda J. Snyder Carnegie Nat. Gas Co.	Samuel B. Brown Carnegie Nat. Gas Co.	Carnegie Sand Co. Carnegie Nat. Gas Co.	Minteer & Craig Lot Minteer & Craig
Patton twp.	Patton twp.	Penn twp.	Penn twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	Wilkins twp.	North Braddock	North Braddock
2,373 2,444	2,468 2,498	2,415 2,439	2,345 2,360	....	2,220 2,240	2,419 2,446	2,177	2,370 2,415	2,325 2,355	....	....
....	....	....	....	2,450 2,485	2,262 2,280	....	....	2,440 2,455	2,370 2,385	2,220 2,250	....
....	2,548 2,558	....	2,448 2,454	....	....	2,524 2,536	 2,304	2,495 2,515	....	....	....
3,067 3,120	....	....	....	2,570 2,575	2,925 2,950	....	....	....	....	....	....
3,195 3,225	....	....	....	....	3,000 3,020	....	....	3,175 3,200	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
3,505 3,553	....	....	....	....	....	....	....	....	....	....	....
3,685 3,712	3,921 3,941	....	....	....	....	....	....	....	....	....	....
3,715	3,945	3,833	2,459	....	3,235	....	2,502	3,347	2,625	2,403	2,283
100′ 5th Sp. Oil Sp.	Brad.	B. I. 4th 4th			Mur. 100′ 4th 4th	4th Eliz. Eliz.	100′ 4th & 5th & 5th	100′ 30′ 4th 4th	100′ 4th		
....	....	....	....	....	....	....	....	....	....	....	500,000

Selected Drill Records

Property name and owner of well		Westinghouse E. & M. Co. Westinghouse E. & M. Co.	Eli Boyd Patton Oil & Gas Co.	Adderly Tri City O. & G. Co.	Van Ormer Brick Yard Tri City O. & G. Co.	Jones Trafford Oil & Gas Co	Shaw Philadelphia Co.	Mary G. Stewart Philadelphia Co.	Wm. H. Roberts #2 Philadelphia Co.
Location of well		Wilkins twp.	Patton twp.	Patton twp.	Patton twp.	Patton twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.
Well number on map		121	122	123	124	125	126	127	128
Elevation of well mouth		±745	1,047	801	810	810	1,098	800	1,064
Base of Pittsburgh coal	---	+260	+1	+290	+305	+420	+167	+440	+200
Salt sand	T	----	----	----	----	530	805	511	----
	B	----	----	----	----	----	897	----	----
Mauch Chunk red shale	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Big Lime	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Big Injun sand	T	880	----	----	----	763	1,015	760	----
	B	1,230	----	----	----	----	1,207	1,165	----
Squaw sand	T	1,255	----	----	----	----	----	1,200	----
	B	1,390	----	----	----	----	----	1,250	----
Berea sand	T	----	----	----	----	----	1,624	1,364	----
	B	----	----	----	----	----	1,660	1,410	----
Murrysville sand	T	1,615	1,880	1,612	1,585	1,512	----	1,482	1,700
	B	1,719	2,001	----	1,695	----	----	1,592	1,825
Hundred-foot sand: Gantz	T	1,734	2,025	1,752	1,730	1,650	1,820	1,629	1,835
	B	1,854	2,130	----	1,835	----	1,950	1,805	1,915
Hundred-foot sand: Fifty-foot	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Thirty-foot sand	T	1,915	----	----	----	1,760	----	----	1,935
	B	1,945	----	----	----	----	----	----	1,965
Snee sand	T	----	----	----	----	----	----	----	----
	B	----	----	----	----	----	----	----	----
Catskill red beds	T	----	----	----	----	1,822	2,092	1,860	----
	B	----	----	----	----	----	2,322	2,070	----
Boulder sand	T	1,980	----	----	----	----	----	----	----
	B	2,000	----	----	----	----	----	----	----
Third sand	T	2,063	2,300	----	----	----	2,138	----	----
	B	2,098	2,320	----	----	----	2,159	----	----
Fourth sand	T	----	2,358	----	----	----	----	1,968	----
	B	----	2,386	----	----	----	----	1,990	----
Fifth sand	T	----	2,430	2,135	2,122	----	2,322	2,070	2,300
	B	----	2,470	----	----	----	2,362	2,105	2,339
Sixth sand	T	----	2,480	----	----	2,086	2,409	2,152	2,385
	B	----	2,505	----	----	----	2,449	2,180	----

Selected Drill Records

M. J. Montgomery Hrs. #1 American Nat. Gas Co.	John E. Mehaffey Peoples Nat. Gas Co.	M. V. Bowman #2 Greensboro Gas Co.	W. L. Feuhr Carnegie Nat. Gas Co.	Swain Magnus American Nat. Gas Co.	Mary R. Hickman Peoples Nat. Gas Co.	Reiss Hempfield O. & G. Co.	Geo. Miller Peoples Nat. Gas Co.	James Michaels Carnegie Nat. Gas Co.	Philip Noser #1 Peoples Nat. Gas. Co.	Grandview Cem. Ass'n. Peoples Nat. Gas Co.	Jas. Shaw Philadelphia Co.
N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.
129	130	131	132	133	134	135	136	137	138	139	140
±800	1,120	855	975	1,000	1,180	1,025	1,175	1,265	±1,135	1,140	±1,030
+475	+145	+370	+212	+205	+80	+235	+65	—50	+60	+15	+0
------ ------	800 910	------ ------	------ ------	755 875	810 880	750 930	------ ------	------ ------	------ ------	------ ------	------ ------
------ ------	------ ------	------ ------	------ ------	895 940	925 1,020	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------
------ ------	------ ------	815 890	845 865	------ ------	------ ------	------ ------	------ ------	1,225 1,285	------ ------	------ ------	------ ------
775 1,085	1,100 1,500	890 1,160	865 1,265	1,020 1,320	1,190 1,325	998 1,110	1,175 1,280	1,285 1,680	1,185 1,600	1,190 ------	1,165 1,510
1,125 1,155	------ ------	1,270 1,350	------ ------	------ ------	------ ------	1,225 1,326	------ ------	------ ------	------ ------	------ 1,625	------ ------
------ ------	------ ------	------ ------	------ ------	1,610 1,637	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	1,800 1,880
1,464 1,575	1,800 1,910	1,515 1,620	1,600 1,719	1,728 1,813	1,884 1,894	1,705 1,820	1,850 1,945	1,950 2,085	1,840 1,980	1,928 2,032	1,890 1,993
------ ------	1,915 2,050	------ ------	1,765 1,858	1,815 1,920	------ 2,100	1,845 1,950	1,930 2,085	2,095 2,180	1,982 2,087	2,051 2,110	2,030 2,160
1,620 1,695	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------
------ ------	------ ------	------ ------	1,868 1,960	1,965 2,015	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------
1,722 1,760	------ ------	------ ------	------ ------	2,035 2,055	------ ------	------ ------	------ ------	------ ------	2,165 2,240	2,210 2,230	2,200 2,240
1,790 2,009	------ ------	------ ------	------ ------	------ ------	------ ------	2,050 2,220	------ ------	------ ------	------ ------	------ ------	2.160 2,373
1,820 1,832	------ ------	1,870 1,900	------ ------	2,065 2,095	------ ------	------ ------	2,195 2,220	------ ------	------ ------	------ ------	------ ------
------ ------	------ ------	1,960 1,975	------ ------	2,115 2,145	------ ------	2,100 2,115	------ ------	2,390 2,415	------ ------	------ ------	------ ------
------ ------	------ ------	------ ------	------ ------	2,170 2,190	------ ------	------ ------	------ ------	------ ------	------ ------	------ ------	2,373 2,425
2,055 2,092	------ ------	2,075 2,100	2,325 2,360	2,215 2,240	2,449 2,485	------ ------	------ ------	2,475 2,487	------ ------	2,400 2,425	2,460 2,500
------ ------	2,395 2,410	2,150 2,175	------ ------	2,295 2,305	2,535 2,570	------ ------	2,455 2,470	2,565 2,567	2,440 ------	2,500 2,530	------ ------

Selected Drill Records

Property name and owner of well		Westinghouse E. & M. Co. Westinghouse E. & M. Co.	Eli Boyd Patton Oil & Gas Co.	Adderly Tri City O. & G. Co.	Van Ormer Brick Yard Tri City O. & G. Co.	Jones Trafford Oil & Gas Co.	Shaw Philadelphia Co.	Mary G. Stewart Philadelphia Co.	Wm. H. Roberts #2 Philadelphia Co.
Location of well		Wilkins twp.	Patton twp.	Patton twp.	Patton twp.	Patton twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.
Elizabeth sand	T		2,568	2,255		2,210			
	B		2,579						
First Speechley or Speechley Stray sand	T								2,754
	B								2,765
Speechley sand	T			2,981	2,973				3,050
	B				3,008				3,052
Tiona sand	T					3,130			
	B								
Sheffield sand	T			3,299					
	B			3,309					
Bradford sand	T			3,545		3,548			
	B			3,595					
Total depth		2,104		3,615	3,040	3,670			3,575
Producing sand		3rd	Eliz.		6th 5th	Salt.	Sp. 5th		6th
Initial production			bbls. 10.7						

Selected Drill Records

M. J. Montgomery Hrs. #1 American Nat. Gas Co.	John E. Mehaffey Peoples Nat. Gas Co.	M. V. Bowman #2 Greensboro Gas Co.	W. L. Feuhr Carnegie Nat. Gas Co.	Swain Magnus American Nat. Gas Co.	Mary R. Hickman Peoples Nat. Gas Co.	Reiss Hempfield O. & G. Co.	Geo. Miller Peoples Nat. Gas Co.	James Michaels Carnegie Nat. Gas Co.	Phillip Noser #1 Peoples Nat. Gas Co.	Grandview Cem. Ass'n. Peoples Nat. Gas Co.	Jas. Shaw Philadelphia Co.
N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Huntingdon twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.
2,132 2,162	2,480 2,515	2,214 2,238	--------	2,358 2,390	--------	2,375 2,404½	--------	2,644 2,664	2,535 2,545	2,598 2,603	2,562 2,582
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	3,230 3,260	-------- --------	3,045 3,057	-------- --------	3,315 3,350	3,119 --------	3,285 3,330	3,385 3,433	3,250 3,265	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,550 3,560	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------		-------- --------	-------- --------	-------- --------	-------- --------	3,610 3,620	-------- --------
-------- --------	3,812 3,822	-------- --------	-------- --------	-------- --------	3,885 3,895	-------- --------	-------- --------	-------- --------	3,905 3,920	3,940 3,952	-------- --------
--------	3,920	2,278?	3,750	--------	3,943	3,181	3,402	3,463	3,948	4,102	--------
	Mur. Eliz.	Mur.		Eliz.	Mur. 5th Sp.	Eliz.	100′		Brad.	Eliz.	Eliz.
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	744,000	750,000	368,640	-------- --------	-------- --------	-------- --------	-------- --------

Selected Drill Records

Property name and owner of well		Ella M. Lyle Carnegie Nat. Gas Co.	Albert Beech Carnegie Nat. Gas Co.	Colonial Trust Co. Carnegie Nat. Gas Co.	Anton Beek Carnegie Nat. Gas Co.	D. R. McKee Peoples Nat. Gas Co.	J. S Heckman Peoples Nat. Gas Co.	J. A. Shaw Carnegie Nat. Gas Co.	Julius Kunkle American Nat. Gas Co.
Location of well		N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	Versailles twp.	Versailles twp.
Well number on map		141	142	143	144	145	146	147	148
Elevation of well mouth		1,052	935	1,080	1,070	1,190	1,010	1,100	1,030
Base of Pittsburgh coal		—20	+140	+70	+120	+60	+200	—23	+185
Salt sand	T		807	884	805				
	B		885	1,065	960				
Mauch Chunk red shale	T								
	B								
Big Lime	T			1,090	1,050				980
	B			1,120	1,080				995
Big Injun sand	T	1,325	1,100	1,120	1,080	1,180		1,250	1,000
	B	1,510	1,320	1,650	1,380	1,500		1,575	1,300
Squaw sand	T		1,325			1,625			1,350
	B		1,415			1,705			1,500
Berea sand	T					1,800			1,580
	B					1,840			1,630
Murrysville sand	T	1,890	1,762	1,812	1,775	1,895		1,903	1,700
	B	2,035	1,857	1,984	1,900	1,995		2,029	1,830
Hundred-foot sand: Gantz	T	2,035	1,862	1,993	1,920	2,025	1,834	2,043	1,831
	B	2,165	1,967	2,093		2,125	1,930		1,945
Hundred-foot sand: Fifty-foot	T								
	B								
Thirty-foot sand	T	2,185	2,010	2,105					
	B	2,205	2,045	2,130					
Snee sand	T	2,270	2,080						
	B	2,295	2,105						
Castkill red beds	T								2,010
	B								
Boulder sand	T		2,138	2,240					2,020
	B		2,160	2,260					2,050
Third sand	T	2,370	2,192	2,274		2,250			2,100
	B	2,430	2,218	2,340		2,270			2,130
Fourth sand	T		2,245						2,160
	B		2,268						2,200
Fifth sand	T	2,480	2,325	2,360		2,375	2,254		2,250
	B	2,500	2,342	2,390		2,385	2,279		2,265
Sixth sand	T			2,430					2,270
	B			2,450					2,290

Selected Drill Records

Peter Beech Peoples Nat. Gas Co.	J. F. Ludwick Peoples Nat. Gas Co.	H. Hoffman Peoples Nat. Gas Co.	Andrew McClure Carnegie Nat. Gas Co.	Alex. Forgie {Apollo Gas Co. {Carnegie Nat Gas Co.	Oliver Evans #1 Carnegie Nat. Gas Co.	Mrs. Marg. McClure Carnegie Nat. Gas Co.	George Rippel Peoples Nat. Gas Co.	L. C. Haler Hrs. Carnegie Nat. Gas Co.	Soles Well #2 Mon Yough O. & G. Co.	Hamilton No. 3 Foster & Brendle	Dougherty Stone Oil & Gas Co.
Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.
149	150	151	152	153	154	155	156	157	158	159	160
940	1,105	846	1,095	855	988.3	1,065	788.9	1,131.5	900	824.2	913
+310	+135	+380	+145	+310	+232	+140	+425	+89	+175	+380	+200
		550 700	815 910		675 785	811 871		850 930		560 645	565 750
			1,028 1,058	838 878	925 955	990 1,010		1,090 1,125		775 815	890 940
895 1,390	1,065 1,400	815 1,145	1,058 1,390	878 1,348	955 1,305	1,010 1,540		1,125 1,460		825 1,140	940 1,260
	1,430 1,605						1,150	1,540 1,6[illegible]0	1,375	1,170 1,320	1,280 1,410
	1,680 1,750			1,455 1,490	1,545 1,605				1,635	1,420 1,455	
1,577 1,728	1,780 1,890	1,500 1,630	1,735 1,845	1,570 1,675	1,669 1,779				1,710	1,520 1,615	1,620 1,700
1,732 1,810	1,920 2,025	1,650 1,730	1,885 1,975	1,680 1,765	1,810 1,870	1,880 1,930 1,940 2,010	1,607 1,659	1,940 2,035	1,874	1,650 1,770	1,990
	2,085 2,098	1,825 1,875	2,005 2,045	1,830 1,850	1,920 1,940	2,020 2,090			2,022	1,815 1,845	
				1,850 2,125	1,910 2,235						
	2,173 2,185		2,085 2,110	1,945 1,970	2,070 2,090					1,910 1,940	
			2,145 2,245		2,140 2,165				2,140	1,970 2,005	
					2,195 2,220				2,185		
	2,335 2,350		2,280 2,330	2,125 2,150	2,235 2,255	2,270 2,295			2,235	2,045 2,060	
2,187 2,197		2,110 2,130				2,320 2,345		2,400 2,412		2,090 2,110	

Selected Drill Records

Property name and owner of well		Ella M. Lyle Carnegie Nat. Gas Co.	Albert Beech Carnegie Nat. Gas Co.	Colonial Trust Co. Carnegie Nat. Gas Co.	Anton Beck Carnegie Nat. Gas Co.	D. R. McKee Peoples Nat. Gas Co.	J. S. Heckman Peoples Nat. Gas Co.	J. A. Shaw Carnegie Nat. Gas Co.	Julius Kunkle American Nat. Gas Co.
Location of well		N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	N. Versailles twp.	Versailles twp.	Versailles twp.
Elizabeth sand	T	2,580	2,438	2,560			2,370		2,349
	B		2,446	2,570			2,381		2,376
First Speechley or Speechley Stray sand	T		3,078						
	B								
Speechley sand	T	3,317		3,235		3,287	3,115		3,070
	B	3,352		3,255		3,328	3,151		3,093
Tiona sand	T						3,225		3,240
	B						3,249		3,265
Sheffield sand	T								
	B								
Bradford sand	T			3,845					
	B			3,870					
Total depth		3,497	3,204	3,907		3,328		2,068	3,300
Producing sands		Mur. Sp.			100′	Mur. 100′	Mur. Eliz. Tiona	100′	Eliz.
Initial production					512,000	2,974,000	1,746,000	974,213	

Selected Drill Records

Peter Beech Peoples Nat. Gas Co.	J. F. Ludwick Peoples Nat. Gas Co.	H. Hoffman Peoples Nat. Gas Co.	Andrew McClure Carnegie Nat. Gas Co.	Alex Forgie {Apollo Gas Co. {Carnegie Nat. Gas Co.	Oliver Evans #1 Carnegie Nat. Gas Co.	Mrs. Marg. McClure Carnegie Nat. Gas Co.	George Rippel Peoples Nat. Gas Co.	L. C. Haler Hrs. Carnegie Nat. Gas Co.	Soles Well #2 Mon Yough O. & G. Co.	Hamilton No. 3 Foster & Brendle	Dougherty Stone Oil & Gas Co.
Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.	Versailles twp.
2,265 2,282	2,458 2,475	2,165 2,205	2,412 2,462	2,200 2,234	2,310 2,340	-------- --------	2,120 2,135	2,470 2,490	2,365 --------	2,160 2,195	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,407 2,437	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
2,970 3,005	3,218 3,236	2,920 2,946	-------- --------	-------- --------	-------- --------	-------- --------	2,889 2,923	3,228 3,255	3,141 --------	2,920 --------	3,037 --------
3,160 3,180	-------- --------	3,125 3,182	3,375 3,433	-------- --------	-------- --------	-------- --------	2,988 3,045	-------- --------	-------- --------	-------- --------	-------- --------
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,580 3,623	-------- --------	-------- --------	3,770 3,785	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,821	4,019	3,182	3,883	--------	2,365	2,477	3,148	3,283	3,172	--------	3,112
100′	Mur. Eliz.			Eliz.	Mur.	Eliz.	100′ Eliz.	Sp.		B. I., Mur. 100′ Eliz. Sp.	
--------	67,392	--------	--------	--------	--------	--------	313,000	--------	--------	--------	--------

Selected Drill Records

Property name and owner of well		J. G. Patterson West Farms O. & G. Co.	Bowman Bros. Co. Peoples Nat. Gas Co.	Frank Wolf Farm Greensboro Gas Co.	Stoner Well McKeesport O. & D. Co.	P. T. B. Shaffer Peoples Nat. Gas Co.	J. B. Pierce #1 Greensboro Gas Co.	Henry G. Gernschat Kurtz Oil & Gas Co.	E. W. Widamy Mona #1, Marks O. & G. Co.
Location of well		Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.
Well number on map		161	162	163	164	165	166	167	168
Elevation of well mouth		775	1,135	1,113	840	1,130	1,030	1,160	770
Base of Pittsburgh coal		+425	+55	+67	+295	—20	±0	—105	+342
Salt sand	T	510	------	904	670	------	------	977	580
	B	695	------	1,080	785	------	------	------	695
Mauch Chunk red shale	T	------	------	------	------	------	------	------	------
	B	------	------	------	------	------	------	------	------
Big Lime	T	------	------	1,135	925	------	1,190	1,271	780
	B	------	------	1,180	1,000	------	1,235	1,350	852
Big Injun sand	T	710	1,200	1,188	1,000	------	1,235	1,390	852
	B	1,050	1,625	1,480	1,440	------	1,545	------	1,180
Squaw sand	T	1,050	------	1,510	------	------	------	------	------
	B	1,100	------	1,645	------	------	------	------	------
Berea sand	T	1,375	------	1,748	------	------	------	1,930	------
	B	1,400	------	1,840	------	------	------	------	------
Murrysville sand	T	1,460	1,845	1,840	1,640	------	1,875	------	1,560
	B	1,550	1,953	1,936	1,700	------	1,955	------	1,670
Hundred-foot sand { Gantz	T	1,580	1,975	1,976	1,775	------	1,955	2,060	1,698
	B	1,700	2,080	2,012	1,895	------	2,020	------	1,786
Fifty-foot	T	------	------	2,022	------	------	2,025	------	------
	B	------	------	2,105	------	------	2,065	------	------
Thirty-foot sand	T	1,700	2,100	------	1,995	------	2,070	------	1,798
	B	1,750	2,135	------	2,600	------	2,110	------	1,930
Snee sand	T	------	------	------	------	------	------	------	------
	B	------	------	------	------	------	------	------	------
Catskill red beds	T	------	------	2,125	------	------	------	------	------
	B	------	------	2,370	------	------	------	------	------
Boulder sand	T	1,802	------	2,144	------	------	2,195	------	------
	B	1,830	------	2,174	------	------	2,210	------	------
Third sand	T	1,867	------	2,235	2,025	------	------	------	------
	B	1,880	------	2,259	2,040	------	------	------	------
Fourth sand	T	1,945	------	2,285	2,085	------	------	------	------
	B	1,965	------	2,350	2,140	------	------	------	------
Fifth sand	T	2,008	------	2,370	2,175	2,470	2,365	------	------
	B	2,030	------	2,397	2,235	2,501	2,380	------	------
Sixth sand	T	------	------	2,414	------	2,517	2,434	------	------
	B	------	------	2,434	------	2,535	2,470	------	------

Selected Drill Records

Anna B. Reynolds Reynolds—Woods	Pgh. Steel Foundry Corp. Pgh. Steel Foundry Corp.	Sollinger Heirs Carnegie Nat. Gas Co.	Pgh. Coal Co.—Johnston Minteer & Young	John Weigle #1 Greensboro Gas Co.	E. P. Howell Philadelphia Co.	W. A. Wilson Wilson Nat. G & O. Co.	Thos. Martin #2 Greensboro Gas Co.	Thos Martin #1 Greensboro Gas Co.	David Pierce Greensboro Gas Co.	Wm. M. McGrew #1 Greensboro Gas Co.	Wm. B. Hayden Peoples Nat. Gas Co.
Versailles twp.	Portvue twp.	Forward twp.	Forward twp.	Elizabeth twp.	Elizabeth twp.	Elizabeth twp.	Sewickley twp.	Sewickley twp.	Sewickley twp.	Sewickley twp.	Versailles twp.
169	170	171	172	173	174	175	176	177	178	179	180
836	745	-------	±870	985	1,110	838	±1,090	990	1,028	940	895
+132	+200	—18	+10	—94	—300	+132	—326	—196	—231	—190	+190
790 -------	735 830	------- -------	------- -------	------- -------	1,163 1,220	------- -------	------- -------	1,151 1,241	1,158 1,350	1,100 1,210	750 870
------- -------	------- -------	------- -------	------- -------	------- -------	1,390 -------	------- -------	------- -------	------- -------	1,385 1,490	1,110 1,440	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	1,475 1,535	1,380 1,391	1,425 1,455	1,400 1,440	------- -------
------- -------	1,015 1,315	------- -------	1,250 1,550	1,349 1,645	1,480 1,750	------- -------	1,539 1,890	1,420 1,435	1,490 1,835	1,440 1,700	------- -------
------- -------	1,345 1,475	------- -------	------- -------	------- -------	1,815 1,860	------- -------	1,890 1,910	1,731 1,749	1,855 1,900	1,760 1,860	------- -------
------- -------	1,588 1,618	------- -------	------- -------	------- -------	2,065 2,079	------- -------	2,070 2,125	1,943 1,973	1,990 2,025	1,960 1,990	------- -------
1,720 -------	1,663 1,800	------- -------	1,850 1,925	------- -------	------- -------	------- -------	2,185 2,261	2,090 2,100	2,110 2,118	2,065 2,070	1,715 1,815
1,880 1,920 -------	1,820 1,935 -------	------- ------- -------	1,955 2,075 -------	2,096 2,166 -------	2,266 2,310 2,380	1,880 ------- -------	2,322 2,347 2,351 2,362	------- ------- -------	------- ------- -------	2,195 2,223 -------	1,845 1,960 -------
2,035 2,070	------- -------	------- -------	2,095 2,110	------- -------	2,380 2,390	------- -------	------- -------	------- -------	------- -------	------- -------	2,000 2,030
------- -------	1,955 1,975	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	2,440 2,600	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	2,085 2,260
2,160 -------	2,068 2,080	------- -------	2,265 2,295	2,365 2,375	2,565 2,573	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
2,200 2,230	2,134 2,166	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------
2,300 2,320	2,212 2,221	------- -------	2,365 2,370	2,490 2,496	2,690 2,695	------- -------	------- -------	------- -------	------- -------	------- -------	2,260 2,275
------- -------	------- -------	2,460 2,500	2,449 2,475	2,533 2,571	2,730 2,742	------- -------	------- -------	------- -------	------- -------	------- -------	------- -------

Selected Drill Records

Property name and owner of well		J. G. Patterson West Farms O. & G. Co.	Bowman Bros. Co. Peoples Nat. Gas Co.	Frank Wolf Farm Greensboro Gas Co.	Stoner Well McKeesport O. & D. Co.	P. T. B. Shaffer Peoples Nat. Gas Co.	J. B. Pierce #1 Greensboro Gas Co.	Henry G. Gernschat Kurtz Oil & Gas Co.	E. W. Widamy Mona #1, Marks O. & G. Co.
Location of well		Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.	Lincoln twp.
Elizabeth sand	T	2,115	2,496	2,485	2,295	2,593	2,545	2,650	
	B	2,130	2,526	2,515	2,365	2,619	2,565		
First Speechley or Speechley Stray sand	T			3,060					
	B			3,080					
Speechley sand	T	2,850	3,253	3,245	2,995		3,278		2,960
	B	2,909	3,300	3,292			3,310		2,982
Tiona sand	T	3,010					3,436		
	B	3,036					3,450		
Sheffield sand	T	3,080							
	B	3,100							
Bradford sand	T	3,400		3,804			3,841		
	B	3,440		3,830			3,862		
Total depth			3,300				4,515	3,449	3,056
Producing sand		100′ 4th Eliz. Mur.	Mur.	Mur. 100′ 4th		Eliz.	B. I. Eliz. Sp.		
Initial production		300,000						1,000,000	

Selected Drill Records

Anna B. Reynolds Reynolds—Woods	Pgh. Steel Foundry Corp. Pgh. Steel Foundry Corp.	Sollinger Heirs Carnegie Nat. Gas. Co.	Pgh. Coal Co.—Johnston Minteer & Young	John Weigle #1 Greensboro Gas Co.	E. P. Howell Philadelphia Co.	W. A. Wilson Wilson Nat. G. & O. Co.	Thos. Martin #2 Greensboro Gas Co.	Thos. Martin #1 Greensboro Gas Co.	David Pierce Greensboro Gas Co.	Wm. M. McGrew #1 Greensboro Gas Co.	Wm. B. Hayden Peoples Nat. Gas Co.
Versailles twp.	Portvue twp.	Forward twp.	Forward twp.	Elizabeth twp.	Elizabeth twp.	Elizabeth twp.	Sewickley twp.	Sewickley twp.	Sewickley twp.	Sewickley twp.	Versailles twp.
2,396 2,439	-------- --------	2,537 2,560	2,527 2,528	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	2,371 2,395
-------- --------	-------- --------	3,145 3,165	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,135 3,145	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	3,157 --------	-------- --------	-------- --------	-------- --------	-------- --------	3,132 3,150
-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,453 --------	-------- --------	3,615 3,642	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,840 --------	-------- --------	3,820 3,858	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------	-------- --------
3,861	2,263	4,113	2,561	2,707	--------	3,325	2,362	2,100	2,166	2,310	3,251
Mur. 4th	B. I. 5th	Sp. St. Shef. Brad.	100′ 30′ Eliz.	B. I.	B. I. 6th		Mur.	B. I. Mur.	B. I. Mur?	B. I.	Eliz.
3,000,000	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

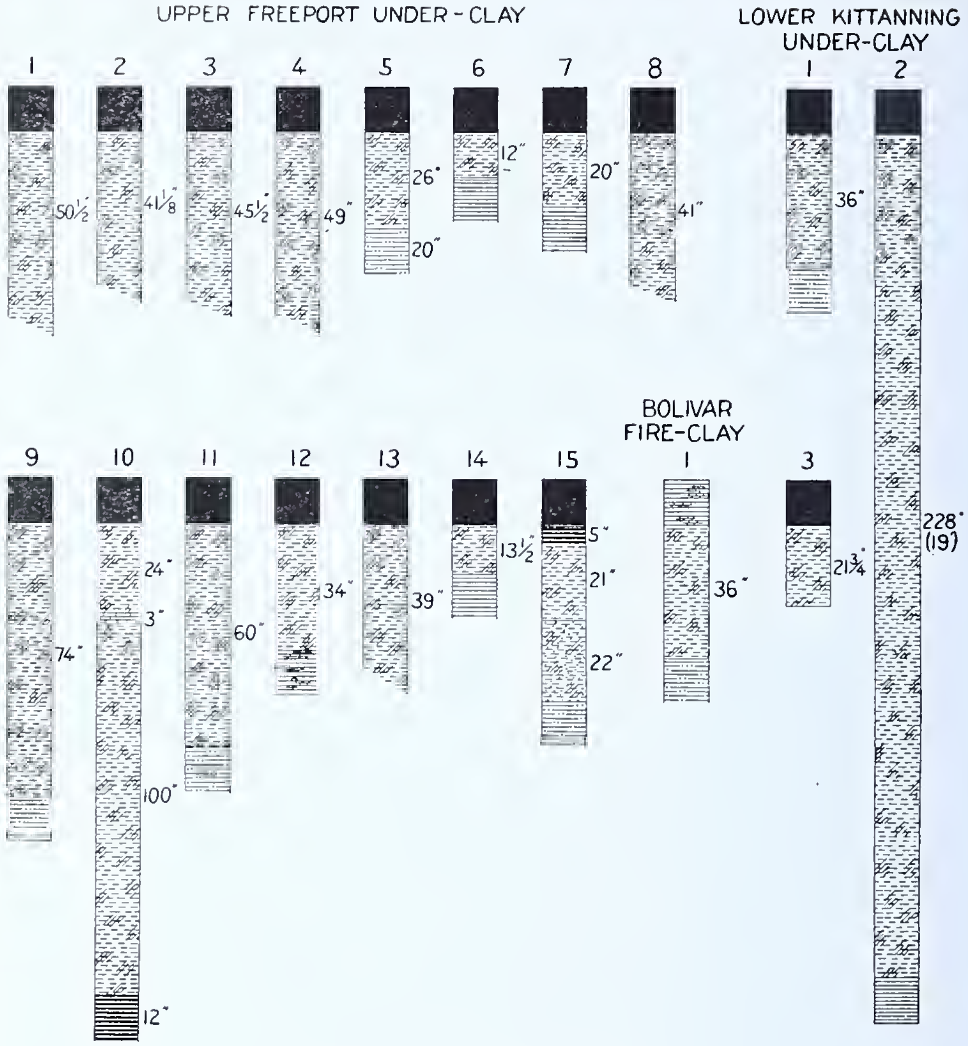


Figure 24. Clay Sections.

Sections of Upper Freeport under-clay

1. Diamond drill-hole, ¼ mile north of B. M. 1194, southeast of Verona.
2. Diamond drill-hole, ⅖ mile northwest of B. M. 1022 on B. & L. E. Railroad, southwest of Unity Station.
3. Diamond drill-hole, Jos. Stotler Heirs farm, 1 mile west of Universal.
4. Diamond drill-hole, James White farm 1 mile southwest of Wilmerding.
5. Diamond drill-hole, Bowman farm, 9/10 mile south of B. M. 1226 near East McKeesport.
6. Diamond drill-hole at site of present shaft of the McKeesport Coal & Coke Company, Versailles.
7. Diamond drill-hole, Hamilton farm, Versailles.
8. Diamond drill-hole, on property line between Miller and Hayden farms and about ⅓ mile southeast of B. M. 881 near Emblem.
9. Diamond drill-hole in valley between Liberty Borough and Portvue.
10. Diamond drill-hole, at B. M. 793 near Boston.
11. Diamond drill-hole, ¼ mile south of Lock No. 3 on Monongahela River.
12. Diamond drill-hole, Hays Estate, ½ mile S-SE. of B. M. 1081 near Terrace.
13. Diamond drill-hole, Hays Estate, ¼ mile NW. of B. M. 1081 near Terrace.
14. Diamond drill-hole, mouth of Becks Run.
15. Diamond drill-hole, 2 miles west of Hays.

Section of Bolivar fire-clay.

1. Diamond drill-hole, 1 1/10 miles S-SW. of the mouth of Becks Run.

Section of Lower Kittanning under-clay.

1. Diamond drill-hole, at Rillton, Sewickley township.
2. Diamond drill-hole, at Greenock.
3. Diamond drill-hole, at B. M. 790 near Hays.

CLAY AND SHALE.

Fire clay.

Most of the better known fire clays occur in the Allegheny group and that group does not outcrop in this quadrangle. Diamond drill-holes to investigate the Allegheny coal beds have shown however (Fig. 24) that the Upper Freeport coal is commonly unlerlain by 2 to 10 feet of clay; that the Bolivar fire clay, separated from the Upper Freeport underclay by 15 feet or more of clay, limestone, shale, or sandstone, occurs in at least part of the quadrangle, and that the Lower Kittanning fire clay in some parts of the quadrangle is very thick. It is unlikely that the Bolivar or Kittanning fire clays can be profitably worked for many years to come; but if tests show the Upper Freeport under-clay to be refractory, it should be possible to devise a scheme of mining whereby the under-clay could be cheaply mined at the same time as the coal. So far as known no tests have yet been made of this under-clay in the vicinity of Pittsburgh.

Other clay beds occur in the Conemaugh and Monongahela groups (see stratigraphic sections in the first part of this report) but most of them are not believed to be sufficiently refractory to be classed as fire clays. The so-called "draw slate" of the Pittsburgh coal bed, which separates the main bed from the roof coal, is perhaps the best of the clay beds. Its average thickness is only 10 to 12 inches, but since it must also be taken out when the main coal bed is mined, it constitutes a cheap source of material for the manufacture of medium grade fire-brick, nozzles, sleeves, and other refractory furnace linings. One plant, the Bessemer Brick Company, located near Large and across Peters Creek valley from the No. 7 mine of the Pittsburgh Terminal Coal Company, has been using the draw slate from that mine for a number of years and is now manufacturing refractory sleeves, nozzles, and runner-brick. The flow sheet of the plant is shown in Figure 25. The molded material from the press is put in coal-fired driers where it remains for 12 to 30 hours depending upon the thickness of the walls of the material being made. It is then stacked in coal-fired, down-draft kilns and burned for 15 days. After that it is slowly cooled and then loaded directly into freight cars for shipment.

The Pittsburgh coal also is underlain by clay having the physical characteristics of a plastic fire clay, but in this quadrangle the under-clay averages only about 6 inches thick and hence is too thin to be

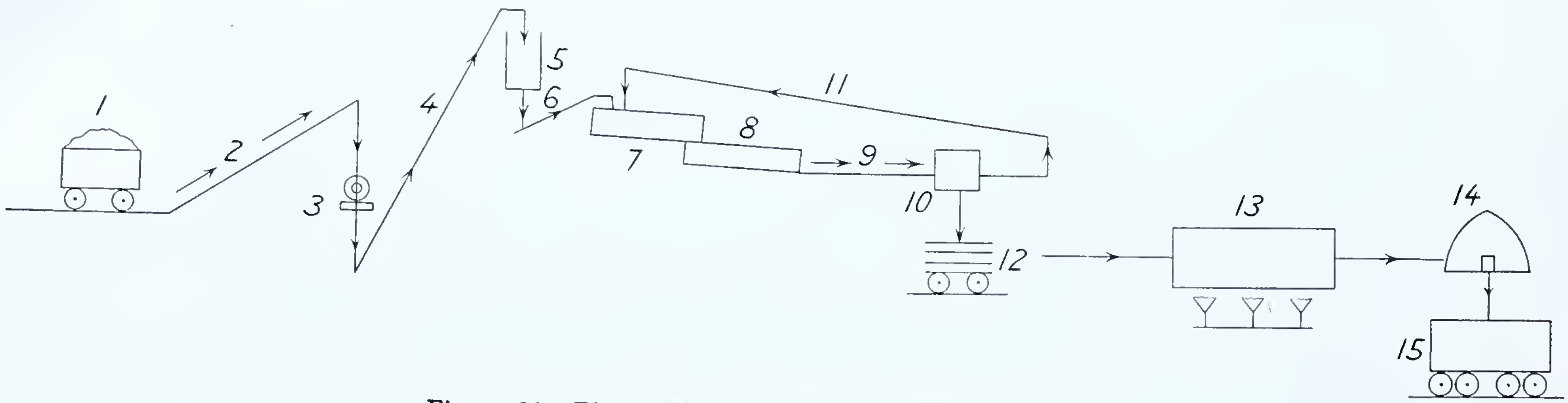


Figure 25. Flow sheet of Bessemer Brick Company plant.

1. Loaded mine car
2. Rope haulage for mine cars
3. Dry pan grinding machines
4. Bucket conveyor
5. Bin
6. Belt conveyor
7. Pug mill
8. Auger and die
9. Table where clay in form of rod is cut to proper length
10. Molding machine or press
11. Bucket elevator for waste material
12. Drying tram cars
13. Driers
14. Kilns
15. Freight cars

worked. Occasionally a gray or white clay is associated with one of the Pittsburgh limestone beds, but the deposits noted were thin and apparently of local occurrence only.

Recently a test has been made[1] for the Pennsylvania Topographic and Geologic Survey of a clay bed occurring just below the Bakerstown coal and which seems to have some of the characteristics of a flint clay. The sample tested came from the mine of the Kay Coal Mining Company at Langdondale, about 1¾ miles east of Hopewell, Bedford County, Pa. The clay bed there is 3 feet thick, homogeneous, slightly stained, hard, and medium gray in color. The results of the test are given to show that refractory clays do occur in the Conemaugh in some regions. In the vicinity of Pittsburgh however, the Bakerstown under-clay does not appear to have the characteristics of a refractory clay. It is hoped that the Pennsylvania Survey will soon be able to arrange for testing all the clay beds which outcrop in the Pittsburgh region.

Test of Bakerstown clay from Langdondale, Bedford County.

Clay sample No. 61.

[W. A. Preische and D. R. Mitchell, Pennsylvania State College, analysts].

Physical properties:
- a. Fracture—splintery
- b. Color—medium gray
- c. Hardness—very hard
- d. Impurities—slight iron
- e. Plasticity—good, short
- f. Water of plasticity—19.13 per cent of weight of dry clay
- g. Time of slaking—4 minutes
- h. Drying shrinkage (linear)—4.00 per cent
  Drying shrinkage (volume) 11.65 per cent of volume of dry test piece
- i. Fusion temperature—Segar cone No. 13, equivalent to a temperature of 1390° C.
- j. Shrinkage water—5.94 per cent of volume of dry clay
- k. Pore water—13.18 per cent of volume of dry clay.

Fired Properties:

Temperature in degrees centigrade	Color	Volume shrinkage in per cent of dry volume	Apparent specific gravity	Per cent porosity in terms of burned weight.
1000	Brown	1.71	2.64	34.1
1050	Red brown	3.64	2.67	33.8
1100	Red brown	7.58	2.73	31.5
1150	Red brown	7.89	2.75	32.1
1200	Black brown	----	----	----
1250	Brown	11.82	2.55	25.3
1300	Black brown	17.36	2.07	0.0

Residual clay and alluvium.

Residual clay deposits in this quadrangle are thin and usually of small extent. The larger deposits occur where the Benwood limestone happens to outcrop at the top of broad, flat-topped hills, as in

[1]Shaw, J. B., Fire clays of Pennsylvania: Pa. Top. & Geol. Survey Bull. No. 10, 1928.

the central part of Mifflin township and in Wilkins township from one to two miles east of Wilkinsburg. The deposits are thin however and are of more value for raising crops than for any manufacturing purpose.

Alluvium forms the banks of many of the larger streams and in the river valleys it covers considerable areas. The land where it occurs is usually too valuable however to consider using the alluvium for brick-making or other industrial uses—particularly so when one considers the very large amount of other material available for that purpose. The best deposits of this type occur in some of the terraces of glacial age. Recent cuts made by the Baltimore & Ohio Railroad south of Snowden have exposed some very homogeneous silt deposits, and other fine deposits have been seen in Homewood, Aspinwall, in the Oakland district, Pittsburgh, and elsewhere. Years ago a terrace deposit of this type occurring on the top of the hill where Duquesne University now stands, was entirely removed and made into bricks.

The similarity of residual and terrace clays is shown in the following analyses.

Analyses of residual clays[1]

	A	B	C
SiO_2	43.07	55.90	55.42
Al_2O_3	25.07	19.92	22.17
Fe_2O_3	15.16	7.30	8.30
FeO	------	.39	trace
MgO	.03	1.18	1.45
CaO	.63	.50	.15
Na_2O	1.20	.23	.17
K_2O	2.50	4.79	2.32
H_2O	12.98	2.54	2.10
H_2O+		6.52	7.76
TiO_2	------	.20	----
P_2O_5	------	.10	------
CO_2	------	.38	------
	100.64	99.95	99.84

A. Residual clay from so-called Trenton limestone, Lexington, Virginia. Analysis by R. B. Riggs.

B. Residual clay from limestone, Staunton, Virginia. Analysis by George Steiger, U. S. Geol. Survey.

C. Residual clay from Knox dolomite, Morrisville, Alabama. Analysis by W. F. Hillebrand.

[1]Clarke, F. W., The data of geochemistry, U. S. Geol. Survey Bull. 770, p. 512, 1924.

Analyses of terrace clay at New Brighton, Pa.[1]

[D. McCreath, analyst].

Constituents	Mendenhall and Chamberlin	Elverson and Sherwood
Silica (SiO_2)	46.160	67.780
Alumina (Al_2O_3)	26.976	12.290
Sesquioxide of iron (Fe_2O_3)	7.214	4.570
Titanic acid (TiO_2)	.740	.780
Lime (CaO)	2.210	.600
Magnesia (MgO)	1.520	.727
Alkalies (Na_2O, K_2O)	3.246	2.001
Water	11.220	6.340
Total	99.286	99.088

Bedded clay and shale.

Experience seems to have proven that the most satisfactory material for the manufacture of building brick is bedded clay and shale; for at the present time every one of the plants making building brick in this quadrangle is digging beds of clay or shale, or both, for that purpose.

The supply of such material is, for this and several coming generations at least, inexhaustible. Most of the clay and shale beds which outcrop in the quadrangle can be used for making building brick. Only those that contain a great deal of mica, a considerable percentage of limestone nodules, or pyrite in the form of large concretions are unfit for such use. Silica is a necessary ingredient of bricks and this is usually obtained by mixing with the clay a certain amount of sandy shale.

Van Ormer Brick Company. The Van Ormer Brick Company's plant at the west end of the borough of Pitcairn is typical of modern practice in brick making. The flow sheet of the plant is as follows.

[1]Pennsylvania Second Geol. Survey, Rept. MM, p. 257, 1879.

Plate XXVI

A. Quarry of Van Ormer Brick Company at Pitcairn.

1. Ames limestone. 2. Red shale. 3. Grafton sandstone. 4. Clay. 5. Duquesne coal. 6. Birmingham shale. 7. Sandstone bed in Birmingham shale.

B. Drilling machine and electrically driven shovel at quarry of Van Ormer Brick Company.

1. Morgantown sandstone. 2. Sandy shale. 3. Clay. 4. Shale.

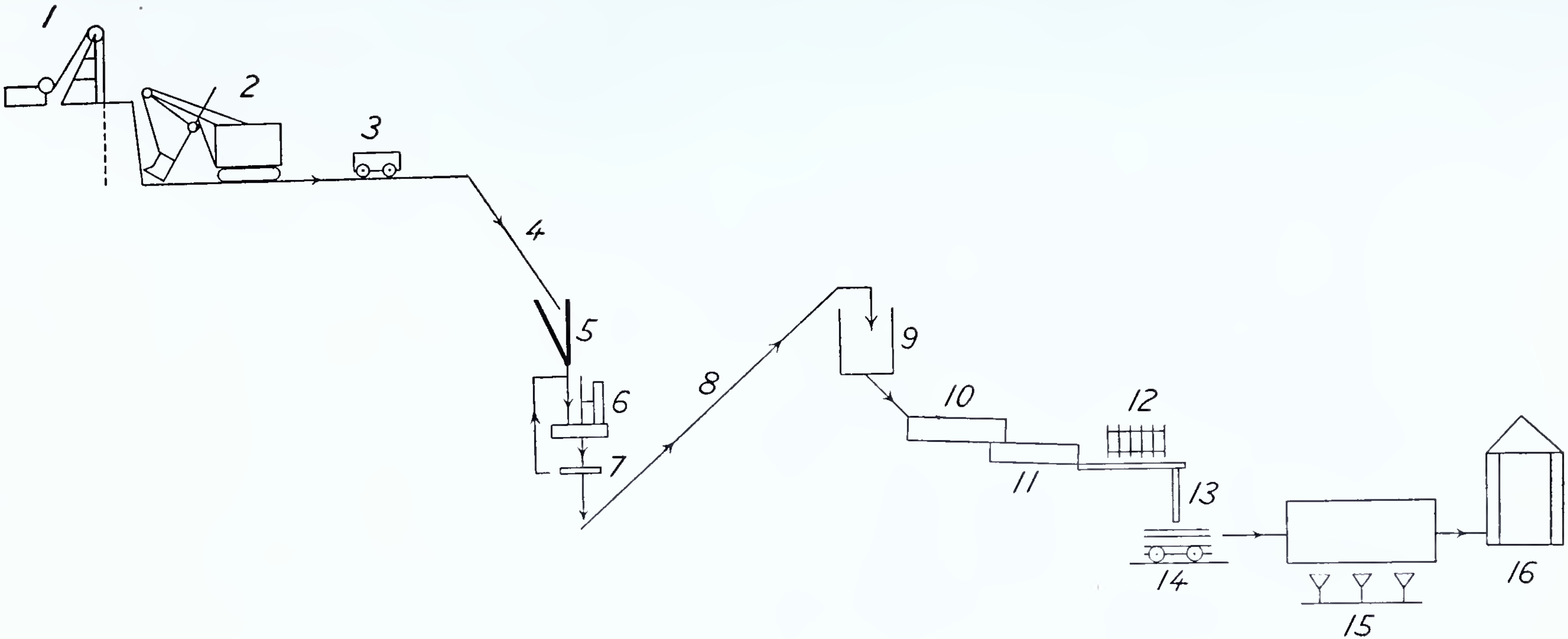


FIGURE 26 Flow sheet of the Van Ormer Brick Company's plant.

1. Gasoline driven drill
2. Electrically operated shovel
3. Material trammed to chute
4. Iron chutes
5. Jaw crusher
6. Dry pan grinding machines
7. Screen
8. Bucket elevator
9. Bin
10. Pug mill
11. Auger machine and die
12. Measuring belt and cutting machine
13. Off-bearing belt
14. Drying tram cars
15. Driers
16. Rectangular type kilns

The bricks are heated in the driers for 36 hours and are then stacked in rectangular down-draft kilns for burning. The stacking is done by hand and this work requires 5½ to 6 days. Burning lasts for 7 days and the cooling requires 4 to 5 days more. The fuel used for drying and burning is natural gas, obtained from a well sunk in the quarry floor. The company prides itself on being able to "turn a kiln", that is, run through the complete process of brick making, in 17 days. As stated, the practice outlined above is the usual practice in the Pittsburgh district. Possibly it has proved to be the most economical process, but to a mere observer it seems as though a large saving might be affected by speeding up the turnover through the installation of a machine to do the stacking. If the time necessary for stacking could be shortened by two, three or even four days—as seems entirely possible—it is believed the wages saved would more than pay for the cost of the stacking machine in one year. Moreover, there would be the additional saving due to lowering the overhead charges per unit produced.

Formerly the shale and clay below the Ames limestone, the shale and clay between it and the Duquesne coal, and the lower part of the Birmingham shale were all used in making bricks; but at present only the upper part of the Birmingham horizon and the lower part of the Morgantown are being used. The latter beds are marked with an asterisk in the following stratigraphic section which was measured at the quarry.

Section at Van Ormer quarry.

		Ft.	in.
Sandstone, massive	Morgantown	8	
*Shale, sandy		23	
*Shale		8	
*Clay, Wellersburg	Birmingham	14	
*Shale		13	
Sandstone, shaly		3	6
Sandstone, massive		9	
Shale		25	
Shale, carbonaceous	Duquesne		5
Coal			8
Coal, bony			3
Clay		8	
Sandstone, massive, Grafton		3	
Shale		15	
Limestone, fossiliferous	Ames	1	
Clay-shale			6
Limestone, fossiliferous			4
Clay-shale			6
Limestone, fossiliferous			10
Shale, greenish-gray		4	
Clay, olive drab		23	

This company makes both face brick and common brick. The following additional plants are now actively engaged in the manufacture of clay products.

Booth and Flynn, Ltd. This company has a large quarry and plant in Pittsburgh, half a mile northwest of the north end of the Brady Street bridge. At the present time they are using a mixture consisting of

	Feet
Shale—Upper Pittsburgh horizon	6
Shaly sandstone—Lower Pittsburgh	14
Sandy shale—Connellsville	40
Red shale—Connellsville	±10

The plant is one of the largest in the district, having a capacity of 60,000 bricks a day. In 1925 they are making only the standard type of building brick, but the darker-colored bricks are so attractive that they are also being used as face brick. Large steam-shovels are used in the quarry and the material is hauled to the plant by an electric motor. The bricks are fired in rectangular, up-draft kilns with coal. Natural gas was formerly used for this purpose but had to be abandoned because of its increasing cost.

Sankey Brothers. This company has a large quarry and brick plant at the foot of the river bluff, due south of the Brady Street bridge. They make both brick and tile and in the past have used all the clay and shale beds occurring between the Wellersburg limestone and a point about 70 feet below the base of the Pittsburgh coal. Recently they have started using the Upper Pittsburgh shale.

In view of the fact that the Upper Pittsburgh shale is finding more and more favor as the material best suited for the manufacture of both face brick and common brick, the following analysis[1] of "shale from Upper Coal Measures," near Pittsburgh, should be of interest.

Analysis of shale from Upper Coal Measures, near Pittsburgh, Pa.

SiO_2	57.537
Al_2O_3	20.127
FeO	5.797
$CaCO_3$, $MgCO_3$, Alkalies } by difference	9.022
H_2O and organic matter	7.517
	100.000

It is also interesting to compare the above analysis with two of shale from the Saltsburg horizon near Johnstown.[2] Sample No 1 is from the upper shale bed and No. 2 from the lower shale bed.

[1] Ries, H., Clays of the United States east of the Mississippi River: U. S. Geol. Survey Prof. Paper 11, p. 235, 1903.

[2] Phalen, W. C., and Martin, L., Mineral resources of Johnstown, Pennsylvania, and vicinity, U. S. Geol. Survey Bull. 447, p. 120, 1911.

Ultimate and rational analyses of shales from hill east of Johnstown.

[A. J. Phillips and P. H. Bates, U. S. Geol. Survey, analysts].

	1.	2.
Silica (SiO_2)	51.32	64.29
Alumina (Al_2O_3)	24.39	17.95
Ferric oxide (Fe_2O_3)	6.94	5.74
Manganese oxide (MnO)	.14	trace
Lime (CaO)	.70	46
Magnesia (MgO)	1.73	1.50
Sulphuric anhydride (SO_3)	trace	trace
Ferrous oxide (FeO)	1.43	1.64
Alkalies (Na_2O)	.23	.35
(K_2O)	1.09	1.80
Water at 100° C.	.92	.95
Ignition loss	11.32	5.44
	100.21	99.92
Free silica	10.09	28.54
Clay substance	81.51	57.85
Feldspathic substance	8.40	13.61
	100.00	100.00

M. Lanz Brick and Tile Company. The plant and quarry of this company are located a quarter of a mile southeast of the Thirtieth Street station (South Side district, Pittsburgh) of the Pennsylvania Railroad, and about two-thirds of a mile east-southeast of Sankey Brothers' plant. At the present time they are using a mixture of the clay and shale beds marked with an asterisk in the following section.

Section at the M. Lanz brick plant.

	Ft.	in.
Limestone, Pittsburgh	1	6
Clay	2	
Sandstone, shaly, Connellsville	9	
Clay	19	
Sandstone	2	
*Shale, sandy at top (lower part used)	7	
Clay and nodular limestone	2	
Shale, sandy	5	
*Clay	34	
*Shale and sandy shale (sandy part discarded)	5	6
Sandstone, massive, Morgantown	25	
*Clay, Wellersburg	12	
Limestone, nodular	1	8
*Shale, red } Birmingham	12	
*Clay-shale } Birmingham	1	4
*Shale, sandy } Birmingham	44	

The company uses coal-fired kilns and driers and has a capacity of 20,000 bricks a day.

Squirrel Hill Brick Company. The plant and quarry of the Squirrel Hill Brick Company are located on the river bluff half a mile south of Schenley Park and almost across the river from the M. Lanz Brick and Tile Company. In the past they have used every clay and shale bed from the top of the Connellsville sandstone to the top of their quarry section. At the present time they are making brick from

4 feet 6 inches of purplish red clay and 10 feet of greenish-yellow shale which occur at the top of the section, and 75 to 90 feet below the base of the Pittsburgh coal. The company makes only one grade of bricks, the best of which are used for face brick, and the remainder as common brick. One kiln is coal-fired, but all the others and the driers are fired with gas.

Iron City Brick and Stone Company. This company has one circular continuous kiln, but most of its bricks are manufactured in built-up, rectangular kilns. Kilns are gas-fired, but coal is used for firing the driers. At present only the top 5 feet of shale in the following section is being used. It is quarried with a steam shovel.

Section at quarry of Iron City Brick and Stone Co.

	Ft.
Shale, light greenish-yellow	5
Clay	5½
Sandstone, Connellsville	6
Shale, sandy	3
Shale	6
Clay, greenish-gray	19
Sandstone, shaly } Connellsville	2
Sandstone, massive } Connellsville	12

In the past, all the clay and shale beds in the above section have been used in the manufacture of common red brick.

The plant and quarry are located on Stanton Avenue about a quarter of a mile northeast of Allegheny cemetery, Pittsburgh.

John H. Ward and Sons Company. Quarry and plant are located on the Frankstown road near the mouth of the branching hollow in the Sterrett district, just north of Wilkinsburg. The company manufactures common red brick from beds occurring above the Little Clarksburg coal and marked with an asterisk in the following section. Formerly the thick beds of clay and clay-shale above the Morgantown sandstone were used.

Section at quarry of John H. Ward & Sons Company.

	Ft.	in.
*Soil	±3	
*Shale, sandy, and some sandstone	15	
*Clay	9	
Shale, sandy and interbedded sandstone, Connellsville	10	
Clay, ferruginous		4
Shale, bituminous, and bony coal, Little Clarksburg	1	5
Clay, impure		3
Shale, carbonaceous		4
Clay	1	6
Limestone	1	
Clay	1	
Limestone	2	
Clay	8	
Clay-shale	4	
Clay	17	
Sandstone, massive, Morgantown	20+	

Hooper Brothers Company. This small company has operated only spasmodically in the last few years. The plant and quarry are located on Blackadore Avenue, half a mile northwest of B. M. 1030 on the Pittsburgh-Penn township boundary line. The company manufactures common red brick from clay and shale beds occurring from 70 to 90 feet below the base of the Pittsburgh coal.

Milliken Brick Company. This company has operated only since 1923. Its plant and quarry are a quarter of a mile north of B. M. 995 on the east boundary of Wilkinsburg. It has four rectangular, down-draft, coal-fired kilns with a total capacity of 36,000 bricks a day. Both face brick and common brick are manufactured. The bricks are made from 30 feet of Upper Pittsburgh shale occurring just above the Pittsburgh coal. Thin beds of sandstone which occur in the shale are discarded.

J. B. Coen Brick and Tile Works. This company's plant and quarry are in the valley of West Run, which bounds Homestead on the west, and about a quarter of a mile from the Pennsylvania Railroad tracks. It has 6 rectangular, coal-fired, up-draft kilns with a large daily output. The raw material used is a mixture of all the beds, excluding the Grafton sandstone, from the top of the Ames limestone to the base of the Morgantown sandstone—a total thickness of 93 feet of clay and shale.

Keller and Milliken Brick Works. The plant and quarry of the Keller and Milliken Brick Works are half a mile north-northeast of the mouth of Turtle Creek. A large output of brick and hollow tile is produced in rectangular, down-draft kilns. The process used is almost identical with that used by the Van Orner Brick Company. When first visited in 1922, the company was using the shale and clay beds above the sandstone in the following section.

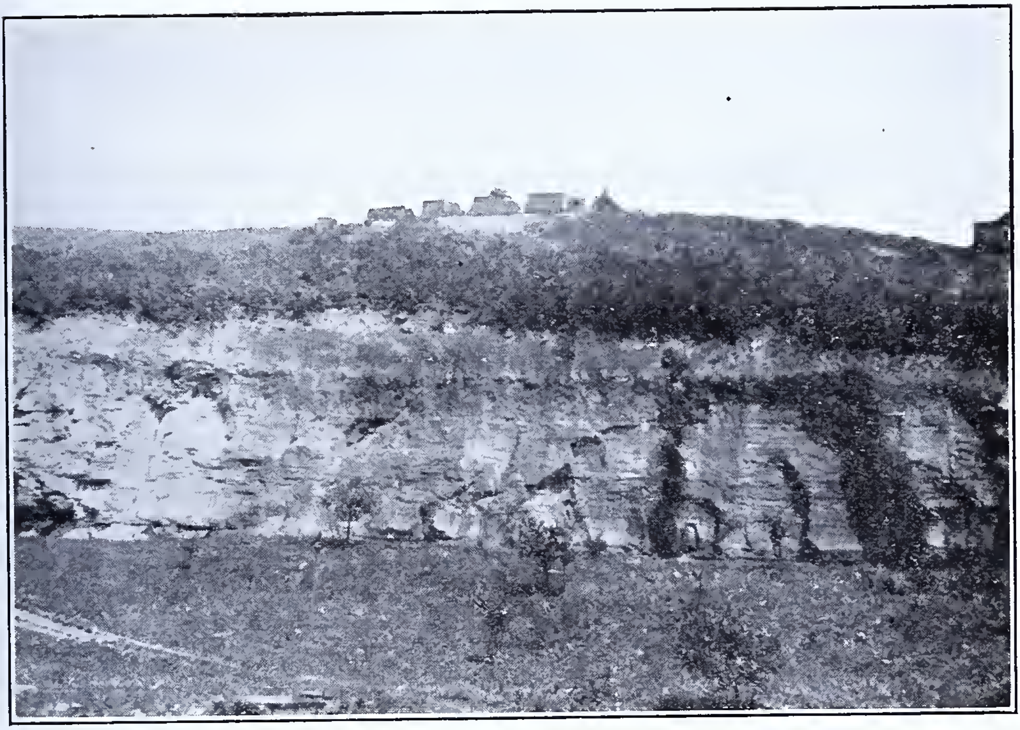
Section at Keller and Milliken quarry.

	Ft.	in.
Shale and thin sandstone beds	5	
Shale	2	
Limestone	1	10
Clay	7	
Limestone		8
Shale	14	
Limestone, nodular		10
Clay	2	
Shale, sandy	38	
Sandstone	16	
Sandstone, very massive beds	66	

When visited in 1925 the company had opened a new quarry in the Upper Pittsburgh shale above the old quarry. Material from the new quarry is trammed to an iron chute and dumped to the old quarry floor. From there it is trammed to the chutes which lead to the plant.

C. M. C. Harper. C. M. C. Harper operates a small brick plant at Boston. The present source of raw material is shale from the

Plate XXVII



A. Quarry of J. B. Coen Brick and Tile Works at West Homestead.

B. Rectangular, up-draft kilns at same plant.

Saltsburg horizon, the quarry being located about half a mile from Boston on the Boston-Greenock road. Formerly a quarry was operated only a third of a mile east of Boston and back from the road, the section at the quarry being as follows:

Section at abandoned quarry ⅓ mile east of Boston.

	Ft.	in.
Terrace deposit of sand and boulders	12	
Shale, light gray } Birmingham	22	
Shale, dark gray } Birmingham	7	
Coal, Duquesne		6
Clay	2	6
Shale, gray and greenish-yellow	32	6
Limestone, fossiliferous, Ames	1	
Clay, olive-green	7	
Clay, limestone nodules	6+	

John Butler. The brick plant operated by John Butler at Greenock is also small. Common brick is made from the lower part of the Birmingham shale, the latter being obtained from a small quarry just above the road in Greenock.

Union Sewer Pipe Company. One firm, the Union Sewer Pipe Company, with a plant at the mouth of Dead Man's Hollow, across the river from Versailles, manufactures nothing but sewer pipe. The manufacturing process is about the same as for brick. The company uses circular, down-draft, coal-fired ovens, and saves one handling charge by loading the finished product directly into freight cars for shipment. In the past all the shale and clay beds from the top of the Pine Creek limestone to the base of the Ames limestone have been used in making their product. At present only the beds marked with an asterisk in the following section are being used.

Section at quarry of Union Sewer Pipe Company.

	Ft.	in.
Limestone, fossiliferous, Ames	1	
Clay	18	
Shale	16	
Clay	4	8
Shale	12	
*Shale, blue-gray	3	
Shale, gray and yellow	32	
Limestone, fossiliferous, Woods Run		2
Coal		3
Clay	5	5
Shale	1	3
Clay	3	2
Limestone		2½
*Shale	35	6
Limestone, sandy, fossiliferous, Pine Creek	1	
Sandstone, massive, Buffalo	25+	

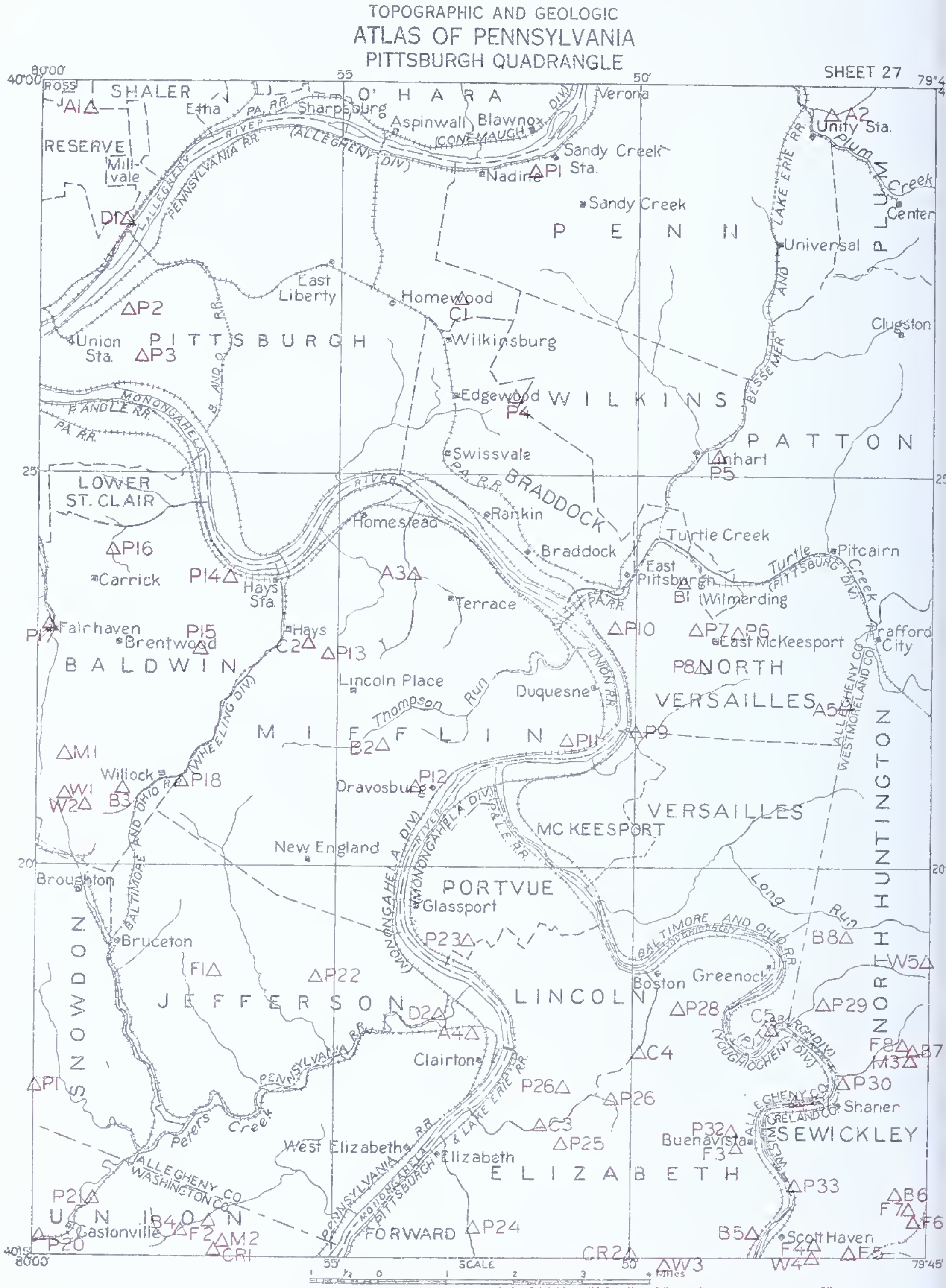


PLATE XXVIII LOCATION OF LIMESTONE SECTIONS SHOWN IN FIGURES. 27 AND 28
A=AMES B=BENWOOD C=CLARKSBURG CR=COLVIN RUN
D=DUQUESNE F=FISHPOT M=MOUNT MORRIS P=PITTSBURGH
W=WAYNESBURG

LIMESTONE.

Character and extent of beds.

The extent and physical characteristics of the limestone beds have already been fully described in STRATIGRAPHY and will not be repeated here. None of the beds are pure limestone and some of the thin fossiliferous beds are exceedingly impure. The thicker limestones (see figures 27 and 28) are similar in composition and would analyze[1] about as follows:

Composition of limestone.

	Per cent
Silica	5 to 8
Alumina	1 to 8
Iron oxide	1.4 to 2.75
Titanium oxide	trace
Calcium carbonate	80 to 85
Magnesium carbonate	2.3 to 5.65
Loss on ignition (other than carbon dioxide)	1.0 to 2.3
Alkalies and undetermined	1.1 to 3.45

The Benwood limestone, because of its greater thickness, is by far the most important of the limestones outcropping in this quadrangle.

Uses.

Road metal. The Benwood limestone has already been quarried at several places and used for road metal. Although limestone is not the best rock for the purpose, it is more durable than either sandstone or shale and has been extensively used for road building in all parts of the world. Its use has not been very extensive in the Pittsburgh quadrangle, except in isolated districts, because of the cheapness and availability of crushed slag, and ashes from old, burned mine dumps. Both the latter materials are used quite extensively in repairing and improving country roads, slag having the preference where the haul from the slag dumps is short. Ashes seem to make a road good enough for light traffic, but in the course of field work many such roads were noted that had been subjected to heavy trucking, and in practically every instance they were in very bad condition. Though the use of limestone for road metal would cost more initially, it is possible that in the long run limestone might be cheaper than ashes.

Lime. None of the limestone beds in this quadrangle are sufficiently pure to make lime for use in chemical or metallurgical processes, but agricultural lime does not have to be pure to produce good results and some farmers are saving a few dollars annually by making their own. The process is simple. A flat area about 10 by 15 feet is cleared, a layer of wood is placed on the ground to give the

[1] Johnson, M. E., Mineral resources of the Greensburg quadrangle: Pennsylvania Top. and Geol. Survey Atlas of Pennsylvania No. 37, pp. 127-133, 1925.

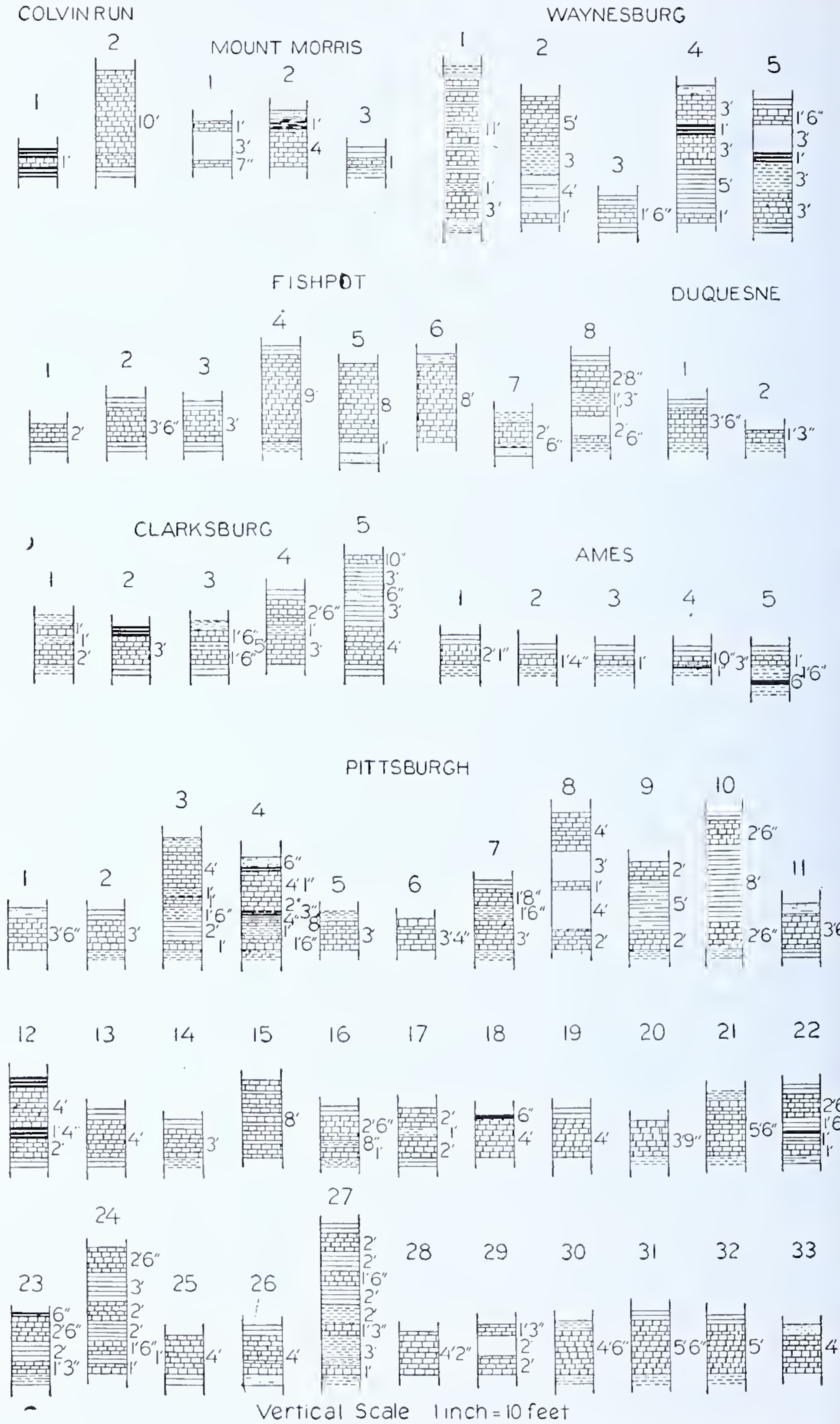


Figure 27. Sections of limestone beds. For location see Plate XXVIII.

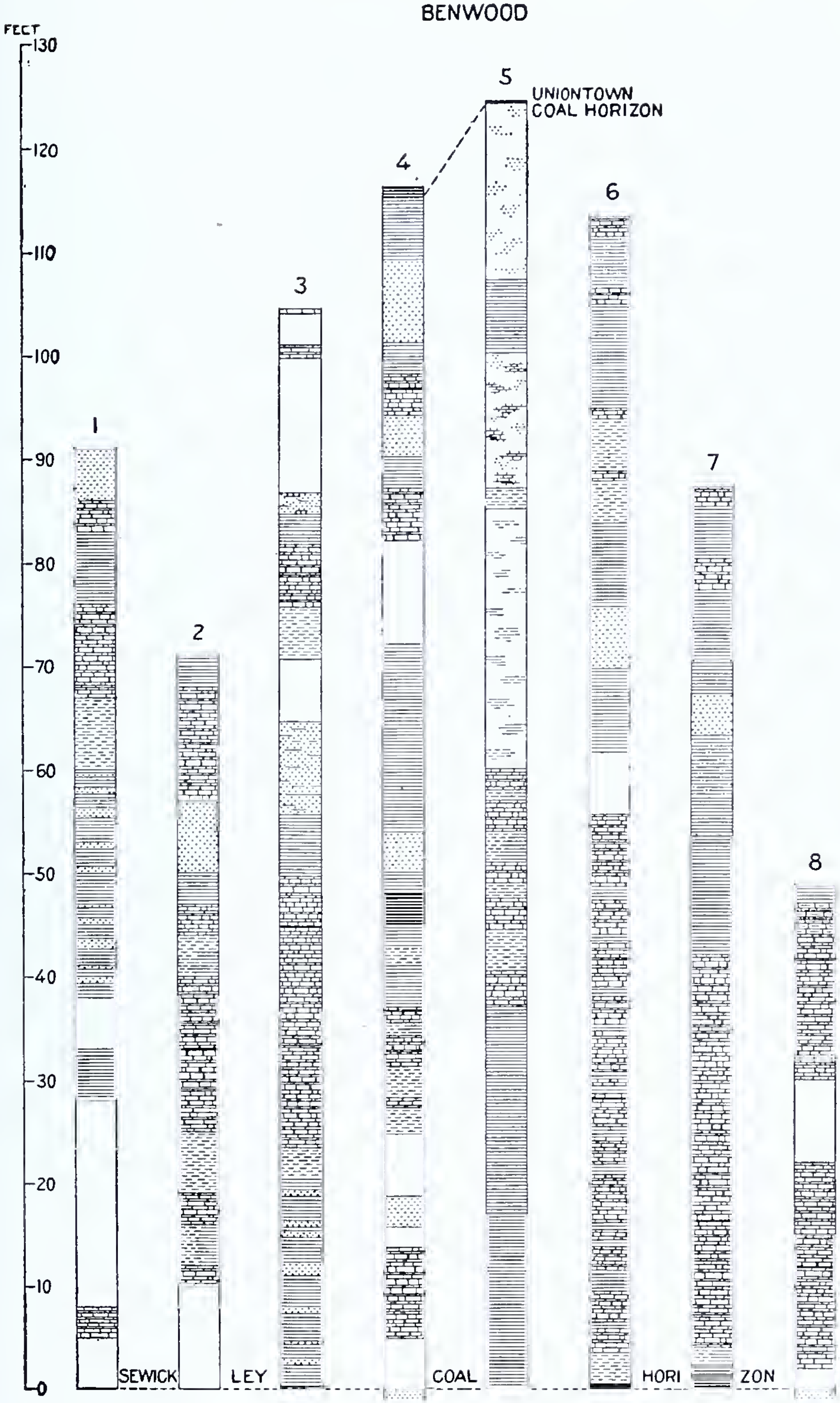


Figure 28. Sections of Benwood limestone.

1. West of Wilmerding. 2. West of Dravosburg. 3. N.W. of Willock. 4. Lables Run, Union Twp. 5. ¾ mi. S.W. of Funk. 6. ⅔ mi. N.W. of Cowansburg. 7. Possom Hollow. 8. ½ mi. E of Emblem.

fire a good start, and then a pyramid of alternate layers of limestone and coal is built. The pile is ignited, allowed to burn itself out, and the burned product is spread on the fields. Results appear to justify the claim that such lime is as good as kiln-burnt lime for conditioning the soil.

Construction. The limestones in this quadrangle are not used for aggregate in concrete, so far as was discovered during field work. The Benwood limestone in adjoining counties has been found to show high tests in the physical laboratory, but in concrete it slacks and spalls so much as to be unsatisfactory for aggregate. Gravel from Allegheny River and the terraces along its banks has proven so satisfactory and so cheap that until its exhaustion it is doubtful if any other material will be able to compete with it.

Limestone is a satisfactory and durable building stone; yet very few houses built of the local limestone were seen in the course of field work. Economic reasons are no doubt responsible for this condition also; for with many competing brick plants located within easy reach of all points in the quadrangle, it is far cheaper to build with brick than with stone. Moreover, some people think that homes built of brick are usually more attractive than those of limestone and they last almost as long. With wood, brick, and cement for concrete work easily available, it is not surprising that the limestones of this quadrangle have never been popular for building purposes.

Limestone has been used to some extent for foundation work, and to a lesser extent for retaining walls. It is well suited for such work and its further use is recommended.

Cement. Only the Benwood limestone occurs in sufficient quantity for use in modern, large-scale cement plants, and not all of the beds in that horizon are suitable for the purpose. Cement manufacturers find that the best cement is obtained from raw material with a uniform composition of about 75 per cent $CaCO_3$, 12 to 15 per cent SiO_2, and the balance Al_2O_3 and Fe_2O_3. There is almost always some $MgCO_3$ present but this is undesirable and should not exceed 5 or 6 per cent.[1] The content of $MgCO_3$ in some beds of the Benwood is known to be over 20 per cent, hence it would be very necessary for any company planning to use the Benwood to analyze each bed carefully. If a sufficient thickness of beds low enough in $MgCO_3$ to make quarrying operations practicable is found, then there is no reason why the Benwood should not be used for making cement; for the right percentages of SiO_2, Al_2O_3, and Fe_2O_3 can be obtained by mixing the right proportion of shale with the limestone. It is questioned however if any place can be found

[1]Miller, B. L., Limestones of Pennsylvania: Pennsylvania Top. and Geol. Survey Bull. M7, p. 42, 1925.

where the Benwood limestone has enough rock of the right composition in such a position as to make quarrying for cement economically practicable. Of four samples collected by R. W. Stone of this Survey at Rices Landing, Greene County, in 1925, three carried more than 20 per cent $MgCO_3$, and the one layer of high grade stone was only 20 inches thick. Limestones averaging 12 per cent magnesia are now being used in Illinois, New York, and other States, in districts where better limestones are not available; in western Pennsylvania the Vanport limestone is used for making Portland cement. It carries less than 2 per cent $MgCO_3$, but does not outcrop in the Pittsburgh quadrangle.

The only cement plant in the quadrangle is at Universal and is operated by the Universal Portland Cement Company. The plant has a capacity of 12,000 barrels of cement a day. The cement is made from fairly pure limestone, shipped into the quadrangle from distant quarries located on the Bessemer & Lake Erie Railroad, and granulated slag from the furnaces of the United States Steel Corporation. The product is a true Portland cement.

Railroad ballast. Crushed limestone has been largely used in the past for ballasting the tracks of the trolley lines and the railroads; but its use for this purpose has been diminishing in recent years, partly because many of the trolley tracks are now being laid in concrete, and partly because other rocks have been found more satisfactory. It is said that the binding quality of crushed limestone is so great that "the expense of removing limestone ballast to replace ties is high as compared with other rock. This binding power, on the other hand, increases the value of limestone as ballast in places where it need not be disturbed."[1]

Filler. Modern industry has found many uses for finely ground, inert fillers. Large quantities of such materials are used to toughen asphalt paving mixtures, and they are also used in paints, rubber, linoleum, certain grades of paper, roofing, whiting, tooth paste, and other products. For some of these purposes the limestones occurring in this quadrangle should be as satisfactory as any other material; for others, such as the manufacture of whiting, they are obviously unsuited.

Flux. In the early days of the iron industry in western Pennsylvania a good deal of limestone from beds in the Monongahela group was quarried and used for flux in the iron furnaces. But the demand for better iron compelled iron makers to use purer limestone, and today few furnaces are using limestone with more than

[1]Miller, B. L., Limestones of Pennsylvania: Pennsylvania Top. and Geol. Survey Bull. M7, p. 39, 1925.

6 or 7 per cent of silica and alumina, combined. Under the circumstances there is little prospect that a demand will ever arise for limestones such as those in the Pittsburgh quadrangle for use as an iron ore flux.

Sandstone.

In Plate XXIX an attempt has been made to show the localities in which each outcropping sandstone is more than 15 feet thick. The figure is not entirely satisfactory in that it does not show the rapid changes in thickness to which every one of the sandstones is subject; nor does the scale of the map permit showing all of the measurements made.

In this plate the numbers represent the thickness of the sandstone and letters are initials of the names of sandstone beds. B—Birmingham, Buf—Buffalo, C—Connellsville, LS—Lower Saltsburg, M—Morgantown, P—Pittsburgh, S—Sewickley, W—Waynesburg.

Waynesburg sandstone. This sandstone is thick only in the southeast corner of the quadrangle. In Sewickley and Elizabeth townships it caps a number of the hills and there are many places where it could be quarried cheaply. As it is a rather soft sandstone, and thin-bedded, its use is not recommended except as a cheap grade of road metal.

Sewickley sandstone. As a rule, only the lower beds of the Sewickley sandstone are massive and there are few places in this quadrangle where a quarry could be located with the certainty of having 25 feet of hard sandstone. Individual beds are seldom as much as two feet thick and are not persistent. Taken as a whole, the Sewickley sandstone is fit only for rough construction work and road metal.

Pittsburgh sandstone. Near Fairhaven the Pittsburgh sandstone is hard, massive-bedded, and thick. Several quarries are located in the vicinity and the stone can be seen nearby in retaining walls and foundations. One home was also seen that was built entirely of this sandstone. None of the quarries are being operated at the present time and it is doubtful if they will be reopened until a demand arises for a more permanent and durable type of home than is now being constructed in that district.

The Pittsburgh sandstone has also been quarried in the southwest corner of North Versailles township, north of Pitcairn, and at one or two other localities (see Plate III in pocket).

Connellsville sandstone. Ordinarily the Connellsville sandstone is so much cross-bedded as to make it unfit for any purpose except the roughest kind of stone work and for road metal. In some places,

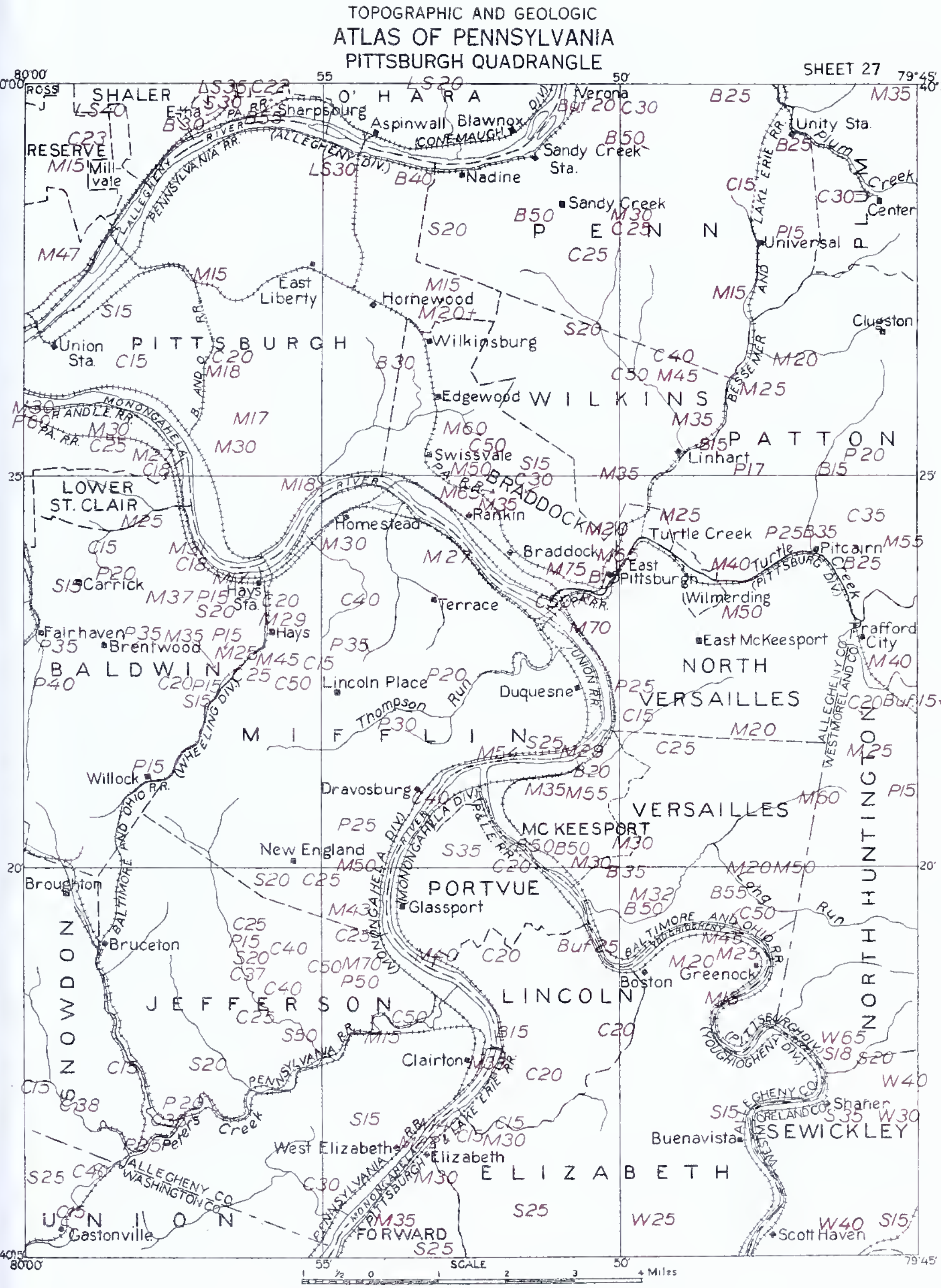


PLATE XXIX DISTRIBUTION AND APPROXIMATE THICKNESS OF MASSIVE SANDSTONES.

Figures denote thickness of sandstone in locality indicated

W=WAYNESBURG P=PITTSBURGH M=MORGANTOWN

LS=LOWER PART OF SALTSBURG S=SEWICKLEY BUF=BUFFALO

C=CONNELLSVILLE B=BIRMINGHAM

however, the beds are very massive, and hence suitable for heavy construction work. Such beds may be conveniently seen at the quarry of the Iron City Brick and Stone Company, near Allegheny Cemetery, and in an abandoned quarry a third of a mile north of the Brady Street bridge, Pittsburgh. The sandstone in these two quarries is medium-grained, gray on fresh fracture or buff when weathered, hard, and massive. The texture is even-grained and it is believed that blocks of the sandstone could be easily cut and shaped on modern stone-working machines.

Where the Connellsville sandstone is in thin beds separated by shale, flags have been frequently used for construction work and in artistic walks.

The Connellsville sandstone seems to have its maximum development along a northeast-southwest line through the center of the quadrangle, but it is thick enough to be quarried in the greater part of all the areas in which it outcrops.

Morgantown sandstone. This is by far the most valuable of the sandstones in this quadrangle. It has an extended outcrop, is usually more than 15 feet thick, and often contains massive, even-grained, buff or gray beds that are suitable for dimension stone. It has been used extensively in the past for all types of construction work and for road metal, and since its outcrop is in many places adjacent to railroads or along improved highways, which provide a ready means of transportation, it is the logical stone to use for all work where strength, durability, and a pleasing appearance are the chief requisites. Occasionally the basal member of the Morgantown is very thick. A maximum of 29 feet was measured in an abandoned quarry at the north end of the Duquesne-McKeesport bridge, but in many other places the same bed is 15 to 20 feet thick. Were it not for the competition of concrete, it is believed the Morgantown sandstone would be in considerable demand for use in the construction of culverts, bridges, chimneys, and permanent types of buildings such as governmental and office buildings. At the present time the Morgantown is being actively quarried about a mile from Monongahela River in the deep valley which almost bisects Rankin. At that point the lower 40 feet of sandstone is quite massive. The stone is used chiefly for foundation walls. It is also being quarried about half a mile west of Sandy Creek, the crushed stone being used for ballast on the tracks of the Verona electric railway.

Birmingham sandstone. The Birmingham sandstone is very thick and massive in the hills back of Sharpsburg, near Sandy Creek, in McKeesport and vicinity, and in the valley of Long Run. In these areas the beds are massive and occasionally two to three feet thick;

Plate XXX

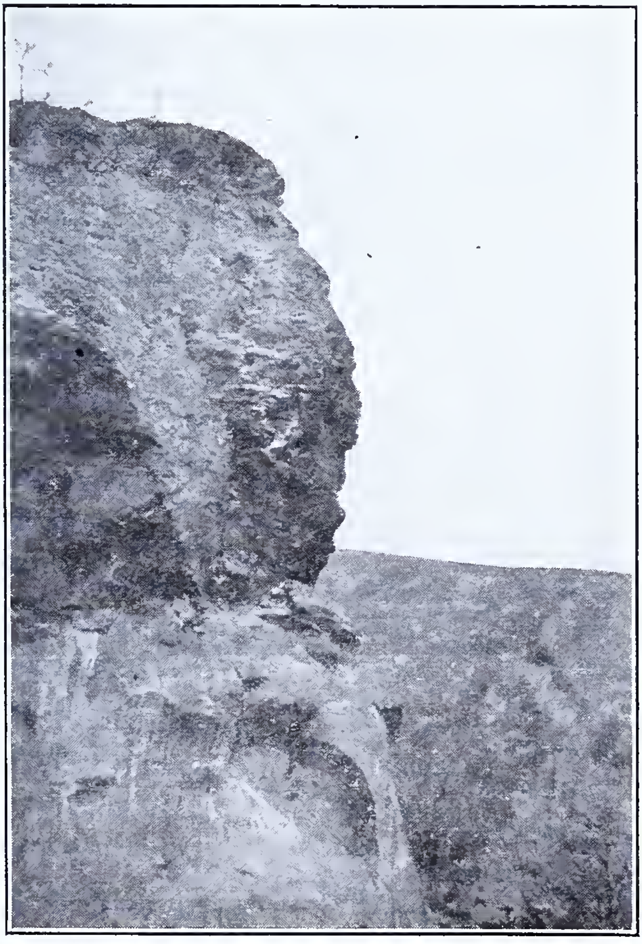
A. Abandoned quarry in Connellsville sandstone, half a mile south of Sandy Creek.

B. Buffalo sandstone at Wittmer, Shaler township, about two miles north of the quadrangle boundary.

but viewed as a whole the sandstone is much cross-bedded and hence it is difficult to obtain flat pieces for construction work. In most places it is only fit for road metal. Near Pitcairn and Unity Station the sandstone is markedly thin-bedded, few beds being more than an inch thick. In 1922 it was being quarried about a mile south of Verona, where the lower 35 feet of sandstone is quite massive. Only the lower 10 feet is being used, however, the upper 25 feet of sandstone being very much cross-bedded.

Saltsburg sandstone. Occasionally as much as 15 feet of cross-bedded sandstone is found in the interval between the Bakerstown coal and the Ames limestone, but usually the sandstone below the Bakerstown is thicker, more evenly bedded, and hence more valuable. In the southeast part of the quadrangle, the Saltsburg horizon, where exposed, is largely composed of shale. The same condition holds in the vicinity of Homestead and Swissvale; but along Allegheny River, particularly west of Aspinwall, the horizon becomes much sandier. North of Millvale and near Etna the lower part of the Saltsburg is quite massive and ranges from 30 to 40

Plate XXXI



Morgantown sandstone in quarry at north end of Duquesne-McKeesport bridge.

Plate XXXII

A. Morgantown sandstone half a mile southeast of Wilmerding station.

B. Near view of basal beds of Morgantown sandstone in same locality.

feet thick. Several quarries have been operated in this vicinity, but they have all been inactive for many years. Plate XIV, illustrates the usual cross-bedded character of this sandstoue.

Buffalo sandstone. Where exposed along Brush Creek south of Trafford City and on both sides of Youghiogheny River near Ver-

sailles, the Buffalo is a massive, thick-bedded sandstone. But since it occurs at water level, quarrying it would be uneconomical owing to the necessity of pumping the water which would certainly accumulate in the floor of a quarry in either locality. The Buffalo sandstone also outcrops south of Verona, but it is less massive there and is interbedded with shale. Both the Birmingham sandstone and the Morgantown sandstone are superior to it in that vicinity.

SAND AND GRAVEL.

All of the sandstones occurring in the quadrangle could be crushed and the resulting sand used in construction work, but they probably will not be used for that purpose for many years to come because of the large supply of sand available in stream deposits of both glacial and recent age. Most of the sand now used is washed from the gravel obtained from the bed of Allegheny River or from the deposits along its shore.

These deposits are very extensive and have been worked for many years without appreciably exhausting the supply. This doubtless would not be the case were it not for the annual periods of high water during which fresh supplies of gravel are brought down from farther up the river. Building contractors have found that the washed sand and gravel from the Allegheny River deposits constitute the very best kind of material for concrete work and these materials have been used in most of the concrete buildings in Pittsburgh and vicinity. Gravel from the Monongahela River deposits is of a different type (see STRATIGRAPHY) and since many of the pebbles are weathered and since also the proportion of clay and sand with the gravel is much greater, therefore making it more expensive to clean the gravel, it is not very much used at Pittsburgh. Sand and gravel is dug from the river bed with specially designed dredges. One of these boats recently put in service has a steel hull 155 feet long, 44 feet wide, and draws 6 feet of water. It has a digging ladder 90 feet long carrying a bucket line of 83 buckets, each of 6½ cubic feet capacity. This ladder will dig 50 feet below the surface of the water and deliver 6½ cubic yards of material per minute to the screens. The sand and gravel is thoroughly washed and screened to different sizes and delivered to barges for transportation to wharves. The principal producers of sand and gravel in the Pittsburgh district are J. K. Davison & Bro., Iron City Sand Co., Keystone Sand & Supply Co., and Rodgers Sand Co. The product of these four firms approximates 4,000,000 tons annually. They employ near 600 men. The James Jiles Company is producing foundry sand at Stayton and Highwood Streets, North Side, Pittsburgh, from a deposit of sand and gravel more

Plate XXXII

Sand and gravel dredges operating near Pittsburgh.

than 100 feet above the river. Sands of different character in the pit face are all mixed in a dry pan grinder, and the product is a coarse, strongly bonded sand used for dry sand casting.

Thickness of deposits. Building contractors in Pittsburgh and vicinity have had a better opportunity than the author to determine the thickness of the different terrace deposits encountered there, but the following information may be of help to some.

Section at Schenley Apartments, Oakland district, Pittsburgh

	Ft.	in.
Surface		
Sand and gravel, stained with iron	1	3
Clay	1	
Sand, with a few pebbles		9
Clay	1	
Sand	4+	

Section ⅛ mile south southwest of above.

	Ft.	in.
Surface		
Silt, with a few sandstone pebbles near the base	7	
Sand	2	
Clay		6+

Section across the street from Aspinwall station.

	Ft.	in.
Surface		
Sand and silt	11	6
Gravel	1+	

Section at Kelly and Sterrett Streets, East Liberty.

	Feet
Surface—crushed stone, road metal	1
Clay, gray and light-brown	8
Sand and gravel	5
Clay	3+

At Duquesne Terrace, opposite the mouth of Turtle Creek, a deep trench for a sewer exposed 18 feet of silt with an occasional large sandstone boulder.

As would be expected, in some places the old, abandoned channels were swept clean of deposits by the action of the river currents. Several such bare spots were noted in Homewood. One occurs near the corner of Reynolds Street and South Dallas Avenue where thin-bedded yellow sandstone is at the surface at an elevation of 978. One block south, where the surface elevation is 982, 9 feet of soft, unconsolidated clay occurs above the red shale which forms the rock surface at that point. Another bare spot can be observed at the corner of Penn Avenue and Brushton Avenue, almost on the eastern boundary of the city.

The following section[1] was measured at a gravel pit on Woodlawn Avenue, North Side district, Pittsburgh, where the elevation of the surface is 232 feet above the river.

Section of high glacial gravels in Allegheny, Pa.

	Feet
Silt, fine, without pebbles	10
Clay, yellow, and small sand lenses	1 to 2
Sand and gravel, well-washed pebbles, mostly 0.01 inch to 2 inches in diameter	4 to 5
Gravel, pebbles, and bowlders up to 4 feet in diameter in a matrix of sand and clay	4 to 7
Gravel and sand, well-washed, with cross-bedding planes sloping downstream	2 to 3
	24

[1]Shaw, E. W., Gravel and sand in the Pittsburgh district, Pennsylvania: U. S. Geol. Survey Bull. 430, p. 391, 1910.

Records of a dozen wells in Pittsburgh show from 75 to 80 feet of river deposit[1]. A well at the Natatorium on Duquesne Way below Sixth Street passed through 72 feet of sand and gravel before striking solid rock. Another on First Avenue passed through 80 feet of loose material; and a third well on Tenth Street went through 61 feet of such material. The first well drilled by the American Iron & Steel Works, located on the east side of Twenty-sixth Street, South Side, near the river, went through 80 feet of surface gravels. The second well, at the foot of Thirtieth Street, South Side, and about 600 yards east of well No. 1, passed through 70 feet of similar material. The well drilled by Morehead & Company at Soho Sta., Second Avenue near Brady Street, and across the river from the American Iron & Steel Works wells, had gone through only 40 feet of unconsolidated material when it encountered solid rock. In the Homewood district the Westinghouse deep well went through 16 feet of sand and gravel, another well nearby only 8 feet, and a third well only 4 feet. The deposits in the East Liberty-Wilkinsburg channel apparently do not anywhere exceed 25 feet in depth and the average depth is of course much less. The terrace deposits in the old channel on the west side of Highland Park are in places at least 27 feet thick and possibly as much as 30 feet. About the same maximum figure holds for most of the higher terraces, the deposits ranging from 5 to 30 or 40 feet thick and averaging 20 feet or less.

Wells in the East Pittsburgh pool went through 30 to 55 feet of alluvium, and one on the grounds of the Westinghouse Foundry Company at Trafford City, through 38 feet. At Glassport, wells on the property of the Pittsburgh Steel Foundry Company passed through 69 to 76 feet of sand and gravel. The following well section[2] at McKeesport illustrates the character of the deposit there. The well mouth is 40 feet above the river.

Section of well at McKeesport, Pa.

	Feet
Silt, sandy	8
Sand, with quartz pebbles and sandstone boulders	11
Sand, with some silt	20
Mud, blue	11
Sand, with quartz and sandstone pebbles	19
Sand, clean	8
Mud, sandy with many boulders	12
	89

The Pierce well, located on the south side of the Baltimore & Ohio Railroad tracks and near the Boston bridge at Versailles went through 75 feet of sand and river gravel.

[1]Jillson, B. C., Home geology or the geology of Pittsburgh and vicinity, Acad. of Sci. and Art of Pittsburgh, p. 3, 1893.
[2]Shaw, E. W., Gravel and sand in the Pittsburgh district Pennsylvania: U. S. Geol. Survey Bull. 430, p. 395, 1910.

WATER RESOURCES.

Climate.

Pittsburgh has about the same climate, and enjoys or endures the same varities of weather, as all southwestern Pennsylvania. The range in temperatures at Pittsburgh during the last ten years is given in the following table.[1]

Temperatures at Pittsburgh.

Year	Degrees Fahrenheit High	Low	Mean
1916	96	—3	52.0
1917	93	—6	49.3
1918	103	—11	52.7
1919	96	1	53.3
1920	89	1	51.4
1921	94	9	55.4
1922	94	5	53.9
1923	92	1	52.6
1924	93	—3	50.3
1925	95	—3	52.4

Highest temperature for 10 year period = 103° F.
Lowest temperature for 10 year period = -11° F.
Mean annual temperature for 10 year period = 52.3° F.

History has proven conclusively that an equable climate is one of the important factors in the commercial and intellectual development of nations. The energy and ability of the men who have made the Pittsburgh district one of the leading industrial centers of the world, was no doubt helped by the fact that they were never subjected to extremes of heat and cold.

Precipitation.

Prolonged dry spells are very rare in the vicinity of Pittsburgh, and rainfall is seldom excessive. The figures in the following table[2] show that precipitation takes place in all twelve months, but ranges from less than 1 to more than 7 inches in a month. From the average figures it is evident that the greatest precipitation may be expected in June and July, and the least in February and November.

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[1]Bliss, G. S., Climatological data, Pennsylvania section: U. S. Dept. Agr., Weather Bur.

[2]Bliss, G. S., Climatological data, Pennsylvania section: U. S. Dept. Agr., Weather Bur. and Precipitation: Water Sup. Com. of Pennsylvania, Water Resources Inventory Report, Part V, pp. 151-152, 1916.

Precipitation at Pittsburgh

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1836 ----------	------	------	------	------	------	------	------	3.28	1.55	2.04	1.59	2.18	--------
1837 ----------	2.66	2.27	1.27	1.00	4.64	7.50	1.70	2.52	1.77	3.93	3.71	2.69	35.66
1838 ----------	1.29	1.94	1.59	------	------	------	------	------	------	------	------	------	--------
1839 ----------	1.40	1.80	1.76	1.80	2.08	2.25	2.40	1.50	3.75	0.60	2.70	3.28	25.32
1840 ----------	1.33	1.33	3.47	2.18	2.93	3.70	1.57	3.89	2.12	2.68	1.71	1.73	28.64
1841 ----------	2.74	0.07	4.77	3.82	2.40	4.97	1.73	4.01	1.85	2.31	2.77	3.41	34.85
1942 ----------	2.75	2.88	3.75	4.64	2.86	4.96	4.90	3.91	2.20	2.09	1.72	3.79	40.45
1843 ----------	2.70	3.31	3.27	2.33	4.05	3.83	1.87	2.32	6.44	3.46	2.87	2.26	38.71
1844 ----------	2.20	0.93	3.04	1.79	4.89	4.02	2.44	4.47	2.57	2.85	1.85	1.50	32.55
1845 ----------	2.85	1.50	3.04	2.51	1.18	4.04	3.74	3.06	3.39	3.37	2.02	1.19	31.89
1846 ----------	2.92	2.73	2.02	3.76	4.62	4.05	7.15	6.05	1.95	4.78	2.60	5.16	47.79
1847 ----------	3.01	2.86	3.47	2.55	3.64	5.32	4.18	3.26	3.92	4.76	4.27	4.98	46.22
1848 ----------	1.31	0.50	3.20	2.45	5.51	3.03	3.69	2.27	2.08	2.11	3.11	4.88	34.14
1849 ----------	2.43	1.31	3.85	0.83	5.83	2.84	1.26	3.26	1.26	3.86	3.97	4.11	34.81
1850 ----------	3.76	3.45	2.74	2.59	3.30	2.62	2.82	1.27	3.62	4.29	2.19	4.76	37.41
1851 ----------	0.35	3.01	1.43	2.83	3.57	2.04	4.30	2.66	2.62	1.45	3.67	1.71	29.64
1852 ----------	1.80	3.34	2.03	9.27	3.84	2.76	2.55	2.76	3.09	2.24	2.67	5.01	41.36
1853 ----------	1.56	3.53	1.11	4.16	3.27	1.32	2.74	6.56	2.34	2.04	2.90	2.10	33.63
1854 ----------	2.23	2.33	2.82	4.21	2.24	2.06	1.45	1.13	1.76	2.89	1.88	1.67	26.67
1855 ----------	2.15	1.77	3.08	2.60	2.33	7.58	5.57	3.57	4.79	1.54	5.07	3.28	43.33
1856 ----------	2.64	1.80	1.73	2.29	2.52	3.99	2.71	1.60	1.95	2.05	1.97	1.34	26.59
1857 ----------	1.86	1.56	1.03	2.50	6.34	5.14	2.89	4.65	2.20	3.66	3.52	3.61	38.96
1858 ----------	1.15	2.78	0.99	4.29	6.60	4.30	3.60	1.90	1.03	2.40	2.37	4.77	36.18
1859 ----------	0.43	2.67	3.83	4.79	2.00	3.02	1.87	5.00	2.74	3.00	1.69	4.67	35.71
1860 ----------	1.75	1.25	1.19	6.56	3.69	2.17	3.09	3.82	1.81	4.45	3.96	2.04	35.78
1861 ----------	1.96	2.65	1.80	3.48	2.70	1.75	4.69	3.00	5.70	------	1.81	0.44	--------
1862 ----------	3.60	1.20	2.87	2.79	2.49	4.00	2.60	1.20	1.51	3.45	2.10	1.57	29.38
1863 ----------	3.91	2.33	2.69	2.17	2.11	3.38	1.42	2.26	2.72	3.43	2.45	2.75	31.62
1864 ----------	1.48	1.77	4.82	2.24	4.46	2.10	2.55	8.29	8.25	------	3.93	2.75	--------
1865 ----------	2.75	1.37	4.83	3.20	5.36	5.48	6.26	5.54	7.56	3.21	1.48	3.46	50.50
1866 ----------	------	------	------	------	------	------	------	------	7.50	4.90	4.46	2.75	--------
1867 ----------	2.58	4.11	4.30	2.90	------	------	------	------	------	------	------	------	--------
1872 ----------	1.85	1.03	1.38	1.09	2.66	2.69	7.77	2.81	2.57	4.37	0.83	2.86	31.91
1873 ----------	3.16	3.08	3.87	3.06	3.42	2.15	3.44	5.19	1.94	6.21	2.13	3.77	41.42
1874 ----------	2.92	3.15	2.94	7.20	2.43	1.84	7.68	1.98	2.56	0.06	3.36	3.30	39.42
1875 ----------	2.17	1.57	3.45	2.09	2.79	2.85	5.27	2.19	2.56	2.36	2.96	3.79	34.05
1876 ----------	3.59	2.83	3.80	2.04	3.35	1.47	5.86	2.72	7.35	1.14	2.03	0.93	37.01
1877 ----------	2.99	1.43	5.31	2.88	1.66	3.54	3.98	2.10	1.90	2.76	4.48	1.69	34.72
1878 ----------	2.52	1.14	2.42	2.60	1.76	5.18	5.15	1.29	5.55	2.99	4.20	3.96	38.76
1879 ----------	1.54	1.74	2.99	1.63	1.20	4.56	7.78	5.56	1.01	0.65	3.36	5.00	37.02
1880 ----------	3.02	2.63	2.77	2.41	1.25	3.52	2.15	3.62	3.12	2.80	1.73	2.95	31.97
1881 ----------	3.55	3.45	3.35	1.81	2.34	6.95	3.86	0.88	0.76	3.75	2.66	3.94	37.30
1882 ----------	4.58	3.14	3.78	1.39	5.80	4.14	1.99	4.50	4.08	1.74	2.07	1.42	38.63
1883 ----------	3.22	4.92	2.51	3.69	5.38	4.73	5.52	3.40	2.47	2.43	1.50	3.40	43.17
1884 ----------	4.82	4.57	3.71	1.11	3.48	1.71	4.04	2.94	1.17	2.02	1.18	4.07	34.82
1885 ----------	4.03	1.90	1.14	2.79	3.26	2.68	2.49	5.64	1.69	4.29	2.57	1.64	34.12
1886 ----------	3.21	1.39	2.85	4.03	3.51	5.17	5.56	2.85	2.86	1.06	4.91	1.81	39.21
1887 ----------	1.92	6.52	1.49	4.29	5.78	4.50	9.51	2.16	2.03	0.39	1.37	1.99	41.95
1888 ----------	6.17	1.74	2.51	1.04	4.13	2.22	4.36	7.26	1.77	3.46	3.57	1.66	39.89
1889 ----------	2.50	1.58	2.32	3.62	6.45	4.93	5.48	1.88	2.87	2.06	4.61	3.07	41.37
1890 ----------	4.18	5.52	3.86	4.87	5.85	3.37	2.22	4.06	4.24	5.66	1.14	5.64	50.61
1891 ----------	2.43	6.09	3.11	1.18	3.23	3.90	7.65	1.60	1.90	1.53	2.61	3.05	38.28
1892 ----------	3.29	1.85	2.29	2.93	3.77	4.15	5.88	2.22	2.04	0.51	1.81	1.92	32.66
1893 ----------	2.36	4.74	1.17	4.94	4.50	2.87	5.08	2.94	1.86	3.22	1.46	2.70	37.84
1894 ----------	2.02	2.98	2.41	3.63	4.63	0.61	1.16	0.43	3.68	1.72	1.80	3.10	28.17
1895 ----------	4.16	0.77	1.73	1.83	1.97	2.26	2.11	4.29	1.83	1.11	2.24	3.20	27.50
1896 ----------	1.63	2.89	4.13	3.39	3.91	4.79	8.96	4.09	4.17	2.26	2.76	1.37	44.35
1897 ----------	1.34	4.30	3.50	3.34	2.70	2.97	4.52	2.08	1.65	0.13	5.11	3.44	35.08
1898 ----------	3.40	1.60	5.45	1.60	3.99	3.98	2.56	4.01	1.06	3.85	2.34	1.92	35.76
1899 ----------	3.41	2.68	3.37	2.59	3.26	3.72	3.13	2.57	2.66	2.10	2.12	2.24	33.85
1900 ----------	1.54	2.86	2.35	1.25	1.34	3.25	3.42	0.84	1.01	2.24	3.64	1.99	25.73
1901 ----------	1.98	0.91	3.69	8.11	5.80	4.41	2.84	4.04	1.96	0.38	1.80	4.84	40.76
1902 ----------	1.49	1.45	4.15	2.70	2.30	5.79	2.94	1.61	2.21	2.79	1.08	3.71	32.22
1903 ----------	2.33	3.99	4.29	2.82	1.67	5.27	5.66	4.71	1.04	2.88	2.60	1.55	38.81
1904 ----------	2.31	2.00	5.11	3.02	3.48	5.76	2.72	2.36	2.35	2.09	0.22	2.34	33.76
1905 ----------	2.36	1.41	3.03	2.07	2.79	6.64	3.01	3.11	2.41	3.54	1.80	3.02	35.19
1906 ----------	1.84	1.09	3.85	1.70	2.08	4.08	4.18	2.96	3.10	2.94	0.95	2.52	31.29
1907 ----------	5.58	0.74	5.24	1.99	1.79	3.17	4.95	1.89	3.25	1.64	1.59	3.03	34.86
1908 ----------	1.65	2.89	5.22	3.59	3.84	1.14	5.07	2.48	0.71	0.95	0.69	1.94	30.17
1909 ----------	3.10	4.47	3.14	5.23	1.51	4.92	1.22	3.33	0.76	2.36	0.84	2.30	33.18
1910 ----------	5.33	3.60	0.37	2.21	3.24	1.94	1.26	2.47	5.50	1.69	1.32	2.87	31.80
1911 ----------	3.36	1.98	1.90	5.42	0.42	2.63	2.17	6.30	6.36	4.94	2.02	3.79	41.29
1912 ----------	1.90	1.80	4.83	4.32	1.56	5.67	6.61	2.39	2.89	2.67	0.80	2.86	38.30
1913 ----------	5.28	2.11	4.37	2.53	3.11	1.04	4.86	2.81	2.86	4.26	2.66	2.60	38.49
1914 ----------	2.41	3.13	2.12	3.98	2.64	3.31	1.89	4.52	0.69	3.07	1.35	4.37	33.48
1915 ----------	4.66	2.24	1.26	1.27	3.84	5.36	3.37	2.73	1.71	2.84	2.37	3.85	35.50
1916 ----------	3.51	2.61	3.63	2.54	2.33	3.82	3.88	4.73	1.63	2.31	1.86	2.01	34.86
1917 ----------	4.33	0.99	3.36	2.20	2.65	3.65	2.33	4.75	1.90	5.27	0.28	1.19	32.90
1918 ----------	2.82	1.87	1.25	2.27	3.89	2.40	2.22	4.84	2.22	3.08	1.79	3.50	32.15
1919 ----------	1.42	1.58	1.89	3.07	4.89	3.58	6.20	7.15	1.64	5.37	3.82	2.81	43.49
1920 ----------	2.80	1.62	1.77	4.42	1.03	6.74	3.29	2.53	3.48	1.48	2.57	1.94	33.67
1921 ----------	3.35	1.80	3.36	1.66	2.49	5.33	2.81	3.03	5.07	2.25	5.06	2.36	38.57

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1922 ----------	1.56	1.57	5.84	3.56	2.59	3.12	2.80	2.35	1.54	1.62	1.31	1.98	29.84
1923 ----------	3.49	2.18	2.15	3.82	3.34	4.28	6.74	4.24	1.62	1.05	2.39	6.22	41.52
1924 ----------	3.53	2.59	4.15	3.09	4.54	4.39	3.10	3.46	5.39	0.12	1.39	1.95	37.70
1925 ----------	3.16	1.91	1.61	1.44	3.42	2.11	3.81	0.96	1.58	4.09	2.70	1.40	28.19
1926 ----------	2.85	3.47	1.70	1.46	2.10	1.20	------	------	------	------	------	------	-------
Average ------	2.72	2.41	2.96	3.02	3.31	3.70	3.86	3.29	2.79	2.66	2.43	2.89	36.08

Surface water.

When rain falls upon the earth, part of it sinks into the ground, and the remainder runs into the streams and is either evaporated or reaches the ocean. A part of the water that sinks into the ground reappears on the surface in springs, and it is this part of the surface water that provides the major part of the flow of streams during droughts. The water run-off during storms and immediately thereafter is sometimes verp rapid. Records[1] kept by the United States Weather Bureau, and others, show that on February 18, 1891, the Allegheny River at Freeport had a discharge of 303,000 cubic feet per second; that on February 23, 1897, the Monongahela had a discharge of 199,000 cubic feet per second at Lock No. 4; that the Youghiogheny near Connellsville had a discharge of 54,400 cubic feet per second on March 14, 1907; and that Ohio River at the Point Bridge, Pittsburgh, had a discharge of 434,000 cubic feet per second on March 15, 1907. Expressed in cubic feet per second per square mile of drainage area, the figures are: Allegheny River, 26.6; Monongahela River, 37.1; Youghiogheny River, 41.2; and Ohio River, 22.8. A discharge rate of 20 cubic feet per second per square mile of the drainage area of these rivers is nearly always sufficient to cause damaging floods.

Some idea of what a flow of 434,000 cubic feet per second means may be had by considering that a stream flowing at that rate would fill a 10,000,000 gallon reservoir in approximately three seconds; and that a cubic tank as high as the Washington monument (555 feet) would be filled in 6 minutes and 34 seconds.

The average flow of the streams is of course only a fraction of their maximum flow. The relation between the two is shown by the following tables[2] of stream-flow measurements made from October 1, 1918, to September 30, 1919—a period of normal precipitation.

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[1]Floods: Water Sup. Com. of Pennsylvania, Water Resources Inventory Report, Part VIII, pp. 73, 79 and 81, 1916.

[2]Report of the Water Supply Commission of Pennsylvania, 1919-1920: pp. 293 and 312.

Monthly discharge of Kiskiminitas River at Avonmore

Month (1918-1919)	Daily discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
October	17,900	452	1,580	0.919	1.06
November	7,950	770	2,670	1.55	1.73
December	10,100	1,090	4,030	2.34	2.70
January	21,900	1,680	4,190	2.44	2.81
February	6,260	945	2,020	1.17	1.22
March	6,860	1,680	3,400	1.98	2.28
April	2,250	1,020	1,550	.901	1.00
May	15,400	1,680	5,530	3.22	3.71
June	2,800	570	1,190	.692	.77
July	3,860	325	1,060	.616	.71
August	7,310	375	1,790	1.04	1.20
September	4,880	330	891	.518	.58
The year	21,900	325	2,510	1.46	19.77

Monthly discharge of Allegheny River at Kittanning

Month (1918-1919)	Daily discharge in second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per square mile	Depth in inches
October	26,400	4,850	9,710	1.08	1.24
November	37,200	6,960	17,900	1.99	2.22
December	44,300	7,980	19,500	2.16	2.49
January	53,000	6,960	17,200	1.91	2.20
February	19,600	3,940	8,980	0.997	1.04
March	44,300	11,000	22,800	2.53	2.92
April	48,600	7,980	20,800	2.31	2.58
May	98,600	16,800	43,700	4.85	5.59
June	14,300	3,490	6,640	0.737	0.82
July	5,580	1,600	2,650	0.294	0.34
August	7,980	1,600	3,780	0.420	0.48
September	6,380	1,600	3,180	0.353	0.39
The year	98,600	1,600	14,800	1.64	22.31

The approximate discharge of the Allegheny where it enters this quadrangle would be the sum of the discharges at Avonmore and Kittanning.

There are many fine springs in the Pittsburgh quadrangle and in the country they supply drinking water for many farms. Springs in and near the many towns and villages should be avoided because of the danger of pollution. The finest-tasting spring water comes from the base of the Ames limestone, the base of one or another of the limestones in the Benwood horizon, and the Morgantown sandstone. Spring water issuing from the base of coal beds is usually acid and disagreeable to the taste.

In any community of more than ten or fifteen people in this area the water supply from springs must be supplemented from other

sources. In small communities an additional supply is usually obtained from wells, but towns and cities must ordinarily depend upon surface water for their supply. The volume of water flowing in the rivers and larger streams in this quadrangle during all times of the year is more than sufficient to meet the water requirements of the cities and towns on their banks. The water supply of the larger communities is given in the following brief descriptions.[1]

Pittsburgh. Entire city, except two small portions supplied by Pennsylvania and South Pittsburgh Water Companies, now supplied from one intake in Allegheny River, at Aspinwall, and the filter plant nearby. Three settling basins; middle receiving basin, capacity 12,000,000 gallons; others 54,000,000 gallons each. Water passes from settling basins through 56 covered, slow sand filter units, each one acre in area; total capacity 200,000,000 gallons daily. Filtered water passes to 50,000,000 gallon covered reservoir. Pumped to equalizing chamber on south side of river and to Brilliant pumping station. From there pumped to reservoirs in Highland Park. Most of city supplied directly from Highland Park reservoirs. Herron Hill and Squirrel Hill supplied from 8,000,000 gallon reservoir on first-named hill at elevation 1256.5.

McKeesport. Entire city except Ward 10 supplied by municipal water plant on east bank of Youghiogheny River. Water from latter river treated and cleaned at plant and pumped to 5,000,000 gallon reservoir at elevation 1020.

Wilkinsburg, Edgewood, North Braddock, Pitcairn, Rankin, Swissvale, Thirteenth ward, Pittsburgh, Turtle Creek and Wilmerding. All supplied by Pennsylvania Water Company. Intake and pumping station are located on Allegheny River at Nadine. Water is pumped to filter plant above at elevation 1300. Filter plant is mechanical; 12,500,000 gallons capacity. Reservoir No. 1, capacity 9,150,000 gallons, used as clear water basin. Reservoir No. 2, capacity 11,500,000 located four miles south. Reservoir No. 3 at Port Perry, capacity 5,000,000 gallons, used as an equalizer to store water delivered from Reservoir No. 2. Reservoir No. 4 on hill between Pitcairn and Wilmerding, capacity 6,290,000 gallons, used for surplus storage. In Pitcairn, auxiliary pumping station forces water to 85,000 gallon steel tank for supply to high service district. The Rankin Municipal Water Works is supplied by Pennsylvania Water Works Company but does the distributing in Rankin.

Braddock. Municipal water works. Two 16-inch drilled wells, 65 feet deep along river bank, receive over 50 per cent river water through intervening sand and gravel. Water pumped to 2,500,000

[1]Water supply: Water Sup. Com. of Pennsylvania, Water Resources Inventory Report, Part VI. 1920.

gallon settling basin on hillside, thence flows to 9,000,000 gallon distributing reservoir nearby.

Homestead. Municipal water works. Water from intake in Monongahela River and sixteen 12-inch drilled wells, 60 to 66 feet deep, along bank of river. Wells receive two-thirds of water from river. Water treated with hypochlorite and pumped to 2,500,000 gallon reservoir on hill at south end of borough.

Duquesne. Municipal water works. Water from drilled wells near Monongahela River, 50 to 65 feet deep. Lifted by air compressor to 220,000 gallon clear water well. Pumped to 500,000 gallon standpipe on hill.

Carrick, Knoxville, St. Clair, Munhall, Mt. Oliver, and Hays. All supplied by South Pittsburgh Water Company from Monongahela River. Intake and Becks Run pumping station on west bank of river, opposite Hazelwood. Water from timber filter crib near east bank and masonry intake pier is pumpd to mechanical filter plant in valley of Becks Run, 1½ miles from river. Settling basin, 4,000,000 gallons capacity, and 400,000 gallons clear water basin at filter plant.

Sharpsburg. Municipal water works. Water from wells averaging 56 feet deep and located about 150 feet from bank of Allegheny River. Natural filtration through sand and gravel. No reservoirs.

Millvale. Municipal water works. Timber filter crib intake in Allegheny River. Water pumped directly to system and to 450,000 gallon steel equalizing tank.

Etna. Municipal water works. Timber filter crib intake in Allegheny River. Water pumped to two 282,000 gallon steel tanks at elevation 278 feet above pumps and distributed by gravity.

Clairton, Glassport, Tenth ward, McKeesport, Elizabeth, Wilson, Dravosburg, West Elizabeth, and Otto. All supplied by Monogahela Valley Water Company. Intake, pumping station and filter plant at upper end of Elizabeth borough. Water pumped to two 100,000 gallon settling basins; from there to mechanical filters; from there to 100,000 gallon clear water basin; and then to system and 1,000,000 gallon equalizing reservoir on high ground east of Patterson. A 1,300,000 gallon reservoir at Elizabeth, ordinarily shut off from system, serves as one emergency supply, and a 500,000 gallon

standpipe at Glassport serves as an emergency supply for Glassport, Dravosburg and the Tenth ward, McKeesport.

When one considers that most of the smaller streams, and all of the larger ones, are polluted by sewage and mine water, the precaution of thoroughly filtering all water that may be used for drinking seems only a matter of common sense. It is to be hoped that some of the municipal water supply systems described above have been improved since the time the report describing them was written.

Ground water.

Ground water in the Pittsburgh district is of two types; that in loose, uncemented material, such as the ordinary valley wash of clay, sand, and fragments of stone; and that in hard, stratified rocks.

Practically all of the hand-dug wells obtain their water from shallow depths and in uncemented deposits of gravel or wash. Where such wells are located in valley bottoms the flow of water is often plentiful, and if in sparsely settled districts, the water may be pure. The majority of such wells however, are located in small villages where the danger from pollution is certainly great.

Many of the communities on Allegheny River obtain an abundant supply of water from wells sunk 50 to 70 feet deep in the gravels along the shores of that river. In percolating from the bed of the river to the wells the water is sufficiently well filtered by the beds of sand and gravel through which it passes to make it potable. But such natural filtration may not be sufficient if the water passes only through gravel, and in any case periodic tests should be made to insure its purity.

Recently the borough manager of Springdale was kind enough to furnish the following information concerning the water supply of that borough.

Springdale. The municipal water supply is obtained from three wells about 65 feet deep. The water obtained has a temporary hardness of 245 and a total hardness of 308. The following record of a 12 inch well, sunk last year, was obtained from the driller.

Log of water well at Springdale.

	Ft.	in.
Soil, ordinary	3	
Sand, brown, with a small percentage of gravel	37	4
Gravel (water at top)	14	
Sand and gravel	9	
Clay, sand, and gravel	1	
Rock, solid	2	2
Total	66	6

The sediments in the banks and bed of Monongahela River contain a much smaller proportion of gravel, consequently the flow of water from wells is small, and where a large supply is needed it is obtained from intakes connected to crib filters on the stream bed.

On the hilltops the water-table, or the upper limit of the portion of the ground wholly saturated with water, is sometimes far below the surface and below the surficial mantle of soil or wash. If no springs are conveniently near, and it is desired to obtain water, then a well must be drilled into the bedded, consolidated rock. Sometimes it is only necessary to drill 50 or 100 feet, but occasionally wells 1,000 feet deep fail to find a satisfactory supply of water. Such dry holes are usually due to the wells being at or near the top of rock folds,[1] whereas to obtain water, wells should be located at or near the bottom of structures.

The fresh water found in bedded rocks gets there either by seeping down through cracks from the surface, or by slow but steady flow from some place where the rock outcrops. The Permian rocks and most of the Pennsylvanian rocks outcropping in this quadrangle are poor water carriers because of their close grain and the frequent occurrence of argillaceous or clayey material intermixed with the sand. Only one sandstone, namely the Morgantown, of all those outcropping in the quadrangle, is believed to offer much possibility of being a water-carrier where covered by other sedimentary rocks. In nearby regions the Mahoning sandstone, near the base of the Conemaugh group, and more particularly the conglomeratic sandstones of the Pottsville series, have been found to contain appreciable quantities of fresh water in places where the structure was favorable, and it is possible that wells in this quadrangle favorably located as to structure, might have equal success. The water found in lower rocks is usually connate water, and salty, or else has migrated there from water-carrying horizons above through deep crevices, or more frequently, through abandoned oil and gas wells. Drillers of oil and gas wells often fail to record data about the depths at which water is encountered, whether it is salty or fresh, its temperature, etc; but if they realized the value of such information they would doubtless be more careful. The following information was gleaned from the records of wells drilled in this quadrangle. Since the cost of drilling below a depth of 1,000 feet would be prohibitive in most instances, and since water found below that depth is usually salty anyhow, information relating to water encountered below a depth of 1,000 feet is omitted.

[1]See Meinzer, O. E., The occurrence of ground water in the United States, U. S. Geol. Survey Water Supply Paper 489, pp. 149-193, 1923, for full discussion of influence of structure on occurrence of ground water.

Water in deep wells

Property name	Owner of well	Location (nearest community)	Depth to water (W) or top of bed in which water occurs.	Kind of water salt (S), or fresh (F) and volume
Am. Iron & Steel Works	Jones & Laughlin Steel Co.	Pittsburgh, South Side	360 (W) 480 (W) 510 (W)	S S S
Boyd's Hill	Dr. Hunter	Pittsburgh	86 587 729	F S S
Dillworth	McCalmont Oil Co.	Homewood	750	S
Morehead & Co.	Morehead & Co.	Pittsburgh	51 200 (W) 325 (W) 380 (W) 480 (W) 550 (W)	F (?) S S S S S
Wallace	Edgewood O. & G. Co.	Edgewood	120 635	F (?) S
E. M. Beech	Mfg. L. & H. Co.	Brentwood	640	F (?)
Davis Heirs	South Hills O. & G. Co.	Brentwood	825	?
Hays Heirs No. 3	South Hills O. & G. Co.	St. Clair	145 (W) 168 665 (W)	? ? ?
David Walker Heirs	Mfg. L. & H. Co.	Willock	810	F (?) 10 bailer per hr.
Cowan	South Hills O. & G. Co.	Brentwood	890 (W)	?
Agnes Wylie Hrs. No. 4	South Hills O. & G. Co.	Hays Sta.	980 (W)	?
W. S. B. Hays	Car. Nat. Gas Co.	Munhall	950 (W)	?
Bunn	Versailles Gas & F. Co.	New England	420 905	? ?
Harry W. McGibbony	Carnegie Nat. Gas. Co.	Hays	315 (W)	?
P. B. S. Co.	Pittsburgh Bessemer Steel	Homestead	127 587 720	S S S
Jos. Walton Farm	Beedle & Samuels	Floreffe	825	?
Wm. Munhall	—	Wallace	653 815	? ?
Louisa Wilson	Carnegie Nat. Gas. Co.	Bruceton	658 (W) 965 (W)	? ?
Torrence Heirs	Mfg. L. & H. Co.	Bruceton	870 (W)	?
Cochran	Philadelphia Co.	Cochrans Mill	352	S
Alliquippa #3	Geo. Farmer & J. E. Stentz	Elizabeth	960 (W)	?
S. M. & T. H. Bowman	Peoples Nat. Gas Co.	Versailles	210 (W) 890 (W)	F (?) S
Bowman Bros. Co.	Peoples Nat. Gas Co.	Versailles	577 (W)	S
Donaldson #1	—	Boston	740 (W)	?
J. G. Patterson	West Farms O. & G. Co.	Versailles	802 (W) 910 (W) 916 (W)	? ? ?
Stoner well	McKeesport Oil & Drilling Co.	Belle Bridge	90 (W)	?
Frank Wolf farm	Greensboro Gas Co.	Boston	50 (W) 571 745	F (?) 5 bailers ? ? 3 bailers
Pgh. Steel Fdry. Co.	Pittsburgh Steel Fdry. Co.	Glassport	500 (W) 547 (W)	? ? Big flow
Pgh. Steel Fdry. Co.	Pittsburgh Steel Fdry. Co.	Glassport	680	?
John A. Boyd	Carnegie Nat. Gas Co.	Linhart	615	? 2 bail.
Anna W. Gilmore	Carnegie Nat. Gas Co.	Linhart	370 735	? ?
Matilda J. Snyder	Carnegie Nat. Gas Co.	Turtle Creek	735	?
Robt. & Ralph Colins	Amer. Nat. Gas Co.	Wilkinsburg	785	?
J. F. Henning Hrs.	Peoples Nat. Gas Co.	Linhart	565 (W)	?
Pgh. Meter Co.	Pittsburgh Meter Co.	E. Pittsburgh	60 (W) 190 (W)	F good flow S

Water in deep wells—Continued

Property name	Owner of well	Location (nearest community)	Depth to water (W) or top of bed in which water occurs.	Kind of water salt (S), or fresh (F) and volume
Pgh. Meter Co.	Pittsburgh Meter Co.	East Pittsburgh	50	F
Westinghouse E. & M. Co.	Westinghouse E. & M. Co.	East Pittsburgh	370 (W)	S
Westinghouse Mach. Co.	Westinghouse Mach. Co.	East Pittsburgh	345	?
Westinghouse Mach. Co.	Westinghouse Mach. Co.	East Pittsburgh	180 (W)	S
Thos. C. Landwehr	American Nat. Gas Co.	Wilkinsburg	120	? small flow
W. F. Craig	Peoples Nat. Gas Co.	Unity Sta.	567-73 (W)	S
Thos. Dunning	Carnegie Nat. Gas. Co.	Universal	585	?
			755	?
Pahlman Heirs	American Nat. Gas Co.	Unity Sta.	560	? 5 bailers
			723	?
Margaret E. Stotler	American Nat. Gas Co.	Unity Sta.	145 (W)	?
			185 (W)	?
B. F. Herr	American Nat. Gas Co.	Universal	85 (W)	F 10 bailers per hr.
			375 (W)	F 25 bailers per hr.
N. W. McLaughlin	T. W. Phillips G. & O. Co.	Unity Sta.	665 (W)	?
John E. Sampson	Wilkinsburg O. & G. Co.	Sandy Creek	805 (W)	?
Say	Wildwood Oil Co.	Sandy Creek	470	S
Chas. H. Thorn	American Nat. Gas Co.	Wilkinsburg	755 (W)	? small flow
Jones	Trafford O. & G. Co.	Trafford City	425 (W)	?
Eli Boyd	Patton O. & G. Co.	Wilmerding	151	? small flow
Jas. & Annie McGregor	American Nat. Gas Co.	Clugston	890 (W)	? small flow
McKinney	P. L. Wally & Co.	Turtle Creek	425	?
L. S. Goehring	American Nat. Gas Co.	Center	840	?
H. H. Brunner	American Nat. Gas Co.	Unity Sta.	275	?
C. M. McLaughlin	American Nat. Gas Co.	Unity Sta.	469	?
Mary G. Stewart farm	Philadelphia Company	Turtle Creek	305	S
W. J. Montgomery hrs.	American Nat. Gas Co.	Turtle Creek	70 (W)	?
			225 (W)	?
M. V. Bowman	Greensboro Gas Co.	Turtle Creek	700 (W)	? 2 bailers
C. E. Felton	Philadelphia Company	Turtle Creek	770 (W)	?
			870 (W)	?
Mrs. Rachel C. Garrett	American Nat. Gas Co.	Turtle Creek	40 (W)	?
			285 (W)	?
Reiss	Hempfield O. & G. Co.	Trafford City	610 (W)	?
Philip Naser #1	Peoples Nat. Gas Co.	Trafford City	965 (W)	?
Albert Beech	Carnegie Nat. Gas Co.	East McKeesport	320	?
Jas. Carothers	Philadelphia Co.	East McKeesport (?)	110 (W)	?
D. L. Clark	Carnegie Nat. Gas Co.	East McKeesport	782	? hole full
Hickman	Northeast O. & G. Co.	Trafford City	890	?
Geo. C. Hoffman	Peoples Nat. Gas Co.	East McKeesport	430 (W)	?
Kelly	W. F. Mintcer	East Pittsburgh	400 (W)	? 4 bailers
D. R. McKee	Peoples Nat. Gas Co.	East McKeesport	351	?
Hamilton #3	Foster & Brendle	Versailles	115 (W)	?
Frank Storch	Philadelphia Company	McKeesport	435	?
Anna B. Reynolds	Reynolds-Woods	McKeesport	860 (W)	?
Julius Kunkle	American Nat. Gas Co.	McKeesport	55 (W)	?
			600 (W)	?
Alex Forgie	Carnegie Nat. Gas Co.	McKeesport	160	? hole full
Pauline Auberle	Youghiogheny Nat. Gas	McKeesport	435 (W)	S small flow
			750 (W)	S big flow
Bayard or Elrod		Versailles	468 (W)	S
			850 (W)	S
			860 (W)	S
Oliver Evans	Peoples Nat. Gas Co.	McKeesport	845 (W)	S
Walter Foster	Philadelphia Co.	McKeesport	740	?
McKee lease	McKeesport O. & D. Co.	Versailles	30 (W)	?
			90 (W)	?
			990 (W)	?
H. S. Newlin	Alladin O. & G. Co.	Versailles	72 (W)	?
			214 (W)	?

Water in deep wells—Concluded

Property name	Owner of well	Location (nearest community)	Depth to water (W) or top of bed in which water occurs.	Kind of water salt (S), or fresh (F) and volume
Peterson #1	Dave Foster & Sam Brendle	Versailles	864 (W)	?
Peterson lease	McKeesport Gas Co.	Versailles	80 (W)	?
P. F. Rhoades	McKeesport O. & D. Co.	Versailles	150 (W)	?
Sherrich	Munhall & Smithman	Versailles	270	S
			590	S
			730	S
Chas. S. Smith	Carnegie Nat. Gas Co.	McKeesport	930	? Hole full
Thos. Martin #1	Greensboro Gas Co.	Scott Haven	620	? small flow
			835 (W)	?
			975 (W)	?
Thos. Martin #2	Greensboro Gas Co.	Scott Haven	952 (W)	?

To summarize,[1] "among all kinds of rocks the best water bearers are deposits of gravel. Next to gravel come sand, sandstone, limestone, and basalt * * * . The most completely unproductive of all materials are the true clays and fine silts, whose original interstices are too minute to yield water and which are too soft to have joints or other secondary openings."

Water power.

The amount of water power possible to develop in the Pittsburgh quadrangle is small, owing to the low gradient of the larger streams, to the fact that a system of dams and locks for navigation purposes now exists in the Monongahela and Allegheny Rivers, and to the further important fact that a dam on any of the larger streams sufficiently high to give a good head of water, would cause the inundation of land so valuable that no power company could possibly afford to pay for it—even if its condemnation were allowed.

It is possible that power for farming purposes or small lighting plants could be developed from the smaller streams; but inasmuch as most of the farms are small, there would be much trouble over water rights almost everywhere such a plant could be operated. Moreover, small plants are inefficient and therefore the cost per unit of power developed would be relatively high. Farmers who installed such plants quite possibly would find that their power was costing them more than they would be charged by one of the large power companies now operating in this district. Large modern plants, burning powdered coal, and situated on the banks of the rivers where a large supply of water for cooling purposes is available (necessary for high efficiency) and where coal can be brought by barge as well as by train, would seem to best answer the power needs of the Pittsburgh district.

[1] Meinzer, O. E., The occurrence of ground water in the United States; U. S. Geol. Survey Water Supply Paper 489, p. 148, 1923.

APPENDIX

Detailed sections of diamond drill-holes in the Pittsburgh quadrangle.

1. Drill-hole No. 1 of the Terminal Coal Company, at the mouth of Becks Run.

	Thickness		Total	
	Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole ---310				
Surface	27		27	
Shale, soft	4		31	
Shale, gray	30		61	
Shale, red	7		68	
Shale, light, sandy	33	6	101	6
Limestone	1		102	6
Shale, gray	11	6	114	
Sandstone	82		196	
Shale, dark	4		200	
Coal, bony, Brush Creek		10	200	10
Fire clay, sandy	12	10	213	8
Shale, red	4	4	218	
Shale, gray	21	9	239	9
Shale, sandy	8	9	248	6
Coal and slate, Mahoning		4	248	10
Fire clay, sandy	3	7	252	5
Shale, sandy, with sandstone partings	26		278	5
Shale, dark	5	10	284	3
Coal, Upper Freeport (thickness confidential)				
Fire clay	1	1½	1	1½
Shale, gray	3		4	1½
Limestone	4		8	1½
Shale, limy	8		16	1½
Shale, dark, sandy, and sandstone	35	6	51	7½
Coal } Lower Freeport	1		52	7½
Slate } Lower Freeport		5	53	½
Coal } Lower Freeport		5	53	5½
Fire clay	3	3	56	8½
Shale, limy	7	6	64	2½
Shale, dark	26	6	90	8½
Slate, black		2	90	10½
Coal, Upper Kittanning	1		91	10½
Shale, dark	2	6	94	4½
Shale, limy	4	6	98	10½
Shale, gray	5	10	104	8½
Shale, limy	6		110	8½
Shale, dark	20	5	131	1½
Sandstone with shale streaks	15		146	1½
Sandstone	14	6	160	7½
Slate, black		10	161	5½
Coal, bony } Mid. Kitt.		3	161	8½
Coal } Mid. Kitt.		8	162	4½
Slate parting } Mid. Kitt.		1	162	5½
Coal } Mid. Kitt.	2	4	164	9½
Fire clay, sandy	1	11	166	8½

2. Drill-hole No. 5 of the Terminal Coal Company, 1⅛ miles south-southwest of the mouth of Becks Run.

	Thickness		Total	
	Ft.	In.	Ft.	In.
Surface	3		3	
Sandstone	39		42	
Shale, dark	2		44	
Space, Pittsburgh coal	10		54	
Lime, bastard	3		57	
Shale, soft	9		66	
Shale, gray	6		72	
Shale, limy	6		78	
Limestone	9		87	
Shale, light-colored	24	6	111	6
Shale, dark	24		135	6
Sandstone	9	6	145	
Limestone	1	6	146	6
Shale, gray	18		164	6
Shale, red		6	165	
Shale, gray	9		174	
Shale, red	22		196	
Shale, green	6		202	
Shale, red	16		218	
Shale, gray, sandy	21		239	
Shale, dark	3		242	
Coal		3	242	3
Shale, soft	6	6	248	9
Shale, limy	7		255	9
Shale, red	1		256	9
Shale, green	8	3	265	
Shale, sandy	40		305	
Shale, dark	3	5	308	5
Lime, bastard	17		325	5
Shale, green	7		332	5
Shale, dark	7	5	339	10
Limestone, Ames		10	340	8
Coal		9	341	5
Shale, dark	1	7	343	
Shale, soft	10		353	
Shale, sandy	16		369	
Sandstone	11		380	
Shale, limy	3		383	
Shale, light-colored, sandy	51		434	
Lime, bastard	4		438	
Shale, dark	6		444	
Shale, red	3		447	
Shale, light-colored, sandy	24		471	
Shale, dark	1	6	472	6
Sandstone	68		540	6
Shale, dark	20		560	6
Sandstone	8	6	569	
Shale, soft	3		572	
Shale, sandy	28		600	
Sandstone	10		610	
Shale, dark	16		626	
Sandstone	35		661	
Upper Freeport horizon				
Shale, limy	6	6	6	6
Fire clay, soft	3		9	6
Shale, sandy	36	4	45	10
Slate, black	8		53	10

2. Drill-hole No. 5—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Coal, Lower Freeport		8	54	6
Shale, dark		7	55	1
Fire clay, soft	5	4	60	5
Shale, dark	6		66	5
Slate, black	9		75	5
Coal, Upper Kittanning	1	1	76	6
Fire clay, sandy	4		80	6
Sandstone	80	4	160	10
Shale, dark	1	1	161	11
Coal, bony		7½	162	6½
Coal		2	162	8½
Sulphur binder (Middle Kittannin)		5½	163	2½
Coal (Middle Kittannin)		¼	163	2¼
Sulphur binder (Middle Kittannin)		½	162	9
Coal (Middle Kittannin)		2½	163	5¼
Binder (Middle Kittannin)		½	163	5¾
Coal (Middle Kittannin)	2	4½	165	10¼
Fire clay	2	11¾	168	10

3. Drill-hole No. 2 of the Terminal Coal Company, in the valley of Glass Run, 1 mile west of Hays Station.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Drill-hole starts at base of Pittsburgh coal				
Surface	25		25	
Sandstone	34	6	59	6
Shale, red	4		63	6
Shale, green	13	6	77	
Shale, sandy	38		115	
Shale, dark	4		119	
Shale, soft	7	6	126	6
Shale, red	2	8	129	2
Shale, light-colored	6		135	2
Shale, red	4		139	2
Shale, sandy	14	3	153	5
Limestone, fossiliferous (Clarksburg(?))	2	9	156	2
Coal (Clarksburg(?))		10	157	
Shale, limy	6		163	
Shale, gray	10		173	
Shale, red	13		186	
Shale, limy	10		196	
Shale, red	5		201	
Shale, soft	10		211	
Shale, sandy	28		239	
Shale, soft	4	6	243	6
Shale, gray	8		251	6
Shale, light, sandy	33		284	6
Shale, dark	5	6	290	
Limestone, Ames	1	6	291	6
Shale, soft	17	6	309	
Shale, light-colored	2		311	
Sandstone	51		362	
Shale, dark	5	6	290	
Coal, bony, Bakerstown		11	365	11
Shale, soft	5	6	371	5
Shale, sandy	5		376	5
Shale, soft	7		383	5
Shale, gray	12	7	396	
Shale, light, sandy	12		408	
Shale, dark	16	6	424	6
Coal, Lower Bakerstown	2	2	426	8
Fire clay, sandy	3		429	8
Shale, sandy	36	4	466	
Sandstone	4	2	470	2
Shale, dark	1	10	472	
Fire clay	2	5	474	5
Limestone, Brush Creek	3	4	477	9
Limestone, bastard	4		481	9
Shale, sandy	3	3	485	
Shale, light, sandy	9		494	
Shale, dark	9		503	
Slate, black	6		509	
Coal and slate, Brush Creek	1		510	
Shale, dark		11	510	11
Fire clay, sandy	1	6	512	5
Coal		7	513	
Fireclay, sandy	2		515	
Shale, dark	15		530	
Shale, dark, with sandstone streaks	21		551	
Sandstone	7		558	
Shale, dark	4		562	
Sandstone	51		613	
Sandstone with coal spars	3		616	
Shale, dark, sandy	4	4	620	4
Coal, Upper Freeport (thickness confidential)				
Fireclay, dark	2	10½	2	10½

4. Diamond drill-hole No. 4 of the Terminal Coal Company, 2 miles west of Hays.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Surface	14		14	
Sandstone	9		23	
Slate, black	1	6	24	6
Limestone	37		61	6
Shale, dark	2		63	6
Limestone	5	6	69	
Shale, soft	2		71	
Slate, black, Sewickley coal horizon	1	2	72	2
Shale, soft	8	4	80	6
Shale, dark	11		91	6
Shale, gray	16		107	6
Shale, light-colored, sandy	13		120	6
Shale, soft	5		125	6
Coal, Redstone		7	126	1
Shale, soft	7		133	1
Shale, gray	7	11	141	
Shale, light-colored, sandy	22		163	
Sandstone	14		177	
Shale, dark	24		201	

4. Diamond drill-hole No. 4—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Coal		7		
Space				
Coal } Pittsburgh		9		
Slate		4		
Coal	1	6	208	2
Limestone, black	3		211	2
Sandstone	8		219	2
Limestone	4	10	224	
Shale, limy	5		229	
Sandstone	4		233	
Shale, limy	5		229	
Shale, gray	8		248	
Limestone	2		250	
Shale, green	9		259	
Shale, limy	9		268	
Shale, gray	5	6	273	6
Shale, red	2		275	6
Limestone, bastard	7		282	6
Shale, limy	10	6	293	
Shale, red	5		298	
Limestone	1		299	
Shale, red	2		301	
Shale, green, sandy	20		321	
Shale, red	6		327	
Limestone	2		329	
Shale, gray	8		337	
Shale, red	8		345	
Shale, gray	20		365	
Shale, sandy	35		400	
Sandstone	22		422	
Shale, gray, sandy	40		462	
Shale, dark	6	6	468	6
Shale, green	15	6	484	
Shale, red	4		488	
Shale, gray	10		498	
Slate, black		5	498	5
Limestone, fossiliferous, Ames	2	7	501	
Shale, dark	2		503	
Coal, Harlem	1	1	504	1
Shale, limy	21		525	1
Shale, red	3	11	529	
Shale, gray	6		535	
Shale, light-colored, sandy	40		575	
Shale, dark	4	8	579	8
Limestone, black, Bakerstown		4	580	
Shale, red	4		584	
Shale, green	8		592	
Shale, sandy	34		626	
Shale, dark	1	8	627	8
Shale, limy, Pine Creek		8	628	4
Sandstone	63	8	692	
Shale, dark	15		707	
Limestone, black, fossiliferous Brush Creek	2		709	
Shale, dark	6		715	
Coal, Brush Creek		11	715	11
Shale, dark	30	9	746	8
Sandstone	23	4	770	
Shale, dark, sandy	18		788	
Sandstone	15		803	
Shale, dark		8	803	8
Coal, Upper Freeport (thickness confidential)				
Shale, dark		5		5
Fire clay, soft	1	9	2	2
Fire clay, sandy	1	10	4	
Shale, gray	2		6	
Limestone, bastard	7	3	13	3
Shale, soft	19		32	3
Sandstone		7	32	10
Sandstone	10	10	43	8
Coal		4		
Fire clay } Lower Freeport		3		
Coal, bony		3	44	6
Fire clay	2	2	46	8
Fire clay, sandy	6	9	53	5
Shale, dark	35	9	89	2
Slate, black		7	89	9
Coal, Upper Kittanning	1	4	91	1
Shale, dark	2	8	93	9
Fire clay, sandy	2	9	96	6
Shale, dark, sandy	17	3	113	9
Sandstone and shale, dark	43	6	157	3
Slate, black		1	157	4
Coal		5		
Slate } Mid. Kitt.		1		
Coal	2	2	160	
Shale, dark		2	160	2
Fire clay	3	6	163	8

5. Drill-hole No. 3 of the Terminal Coal Company, at B. M. 790 near Hays.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 280				
Surface	44		44	
Shale, red	39		83	
Shale, gray	17		100	
Shale, red	8		108	
Shale, soft	4	6	112	6
Shale, red	2	4	114	10
Shale, gray	7		121	10
Shale, red	4	2	126	
Shale, sandy, gray	25		151	
Shale, red	1		152	
Shale, gray	1		153	
Shale, dark	5		158	
Shale, soft	5	6	163	6
Shale, red	2	0	165	6
Shale, gray	2		167	6
Shale, soft	1	6	169	
Shale, gray	7		176	
Shale, light-colored	46		222	
Sandstone	58	3	280	3
Shale, dark	9	3	289	6
Coal, Mahoning		11	290	5
Fire clay, sandy		2	290	7
Shale, soft	7	5	298	
Shale, soft, with red shale streaks	3		301	
Shale, sandy	14		315	
Sandstone	7	6	322	6
Shale, light-colored, sandy	6	6	329	
Shale, dark	8		337	
Coal, Upper Freeport (thickness confidential)				
Shale, dark	3		3	
Shale, gray	12	2	15	2
Shale, dark	4		19	2
Sandstone with coal spars at bottom	17		36	2
Conglomerate	11		47	2
Sandstone and sandy shale	37		84	2
Sandstone	111		195	2
Coal		2	195	4
Sandstone	4	6	199	10
Shale, hard, dark	8	10	208	8
Coal, bony		3	208	11
Coal } Lower Kittanning		1¾	209	¾
Slate binder		1	209	1¾
Coal	3	2½	212	4¼
Fire clay	1	9¾	214	2

6. Drill-hole No. 3 of John Rayburn and others, ¼ mile south of Lock No. 3 on Monongahela River.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 141				
Surface	25	----	25	----
Sandstone	10	----	35	----
Shale, sandy	15	----	50	----
Sandstone	5	----	55	----
Shale, sandy	13	----	68	----
Sandstone	1	----	69	----
Shale, variegated	20	----	89	----
Shale, red	20	----	109	----
Shale, sandy	17	----	126	----
Shale, dark	4	----	130	----
Bone,-Duquesne	----	8	130	8
Slate	----	6	131	2
Fire clay	4	----	135	2
Shale	31	10	167	----
Limestone, fossiliferous, Ames	4	----	171	----
Coal and bone,-Harlem	----	8	171	8
Lime and shale	13	4	185	----
Shale	18	----	203	----
Shale, sandy	15	----	218	----
Sandstone	15	----	233	----
Shale, dark, sandy	27	----	260	----
Shale, variegated	29	----	289	----
Shale, sandy	16	----	305	----
Slate	----	6	305	6
Limestone,-Pine Creek	1	6	307	----
Shale	11	----	318	----
Shale, sandy	44	----	362	----
Shale, dark	18	----	380	----
Bone, Brush Creek	----	2	380	2
Shale	16	----	396	2
Sandstone	3	----	399	2
Shale	8	10	408	----
Sandstone	22	----	430	----
Shale, sandy	3	----	433	----
Sandstone	4	8	437	8
Shale, sandy	11	----	448	8
Slate	----	4	449	----
Cannel coal } Upper Freeport	----	2	449	2
Clean coal } Upper Freeport	2	2	451	4
Bone } Upper Freeport	1	2½	452	6½
Clean coal } Upper Freeport	3	----	455	6½
Fire clay	5	----	460	6½
Shale, light-colored, sandy	10	----	470	6½
Slate	----	2½	470	9
Bone, slatey,	1	4	472	11
Sandstone	27	11	500	----
Shale	1	3	501	3
Slate	----	3	501	6
Shale, sandy	2	----	503	6
Sandstone	5	----	508	6
Shale, sandy	9	----	517	6
Slate	----	6	518	----
Coal, Lower Freeport	1	----	519	----
Fire clay	3	----	522	----
Total depth 522 ft.				

7. Drill-hole No. 2 on the Hays Estate, ¼ mile northwest of B. M. 1081 near Terrace, drilled for L. B. and V. C. Hays.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 10				
Surface wash	8	----	8	----
Shale, soft, gray	7	----	15	----
Limestone	5	----	20	----
Limestone and shale, limy	16	----	36	----
Shale, light-colored, sandy	9	----	45	----
Shale, soft, limy	10	----	55	----
Shale, red and green, clay	11	----	66	----
Shale, gray, sandy	27	----	93	----
Shale, dark, sandy	6	----	99	----
Limestone and shale, limy	2	----	101	----
Shale, gray, sandy	39	----	149	----
Sandstone	4	----	144	----
Shale, red and green, clay	8	----	152	----
Shale, gray, sandy	10	----	162	----
Shale, red, clay	8	----	170	----
Shale, red and green, clay	12	----	182	----
Shale, red, clay	42	----	224	----
Shale, red and green, clay	31	----	255	----
Slate	2	6	257	6
Coal, bony,-Duquesne	----	6	258	----
Clay, soft	7	----	265	----
Shale, light-colored, sandy	7	----	272	----
Sandstone	3	6	275	6
Shale, red and gray, clay, with limestone	33	6	309	----
Shale, gray, sandy	33	----	342	----
Shale, red and gray, clay	12	----	354	----
Shale, gray, clay	3	----	357	----
Shale, light-colored, sandy	3	----	360	----
Shale, red and green, clay	4	----	364	----
Shale, gray	26	----	390	----
Shale, dark	15	----	405	----
Shale, fossiliferous } Woods Run	----	6	405	6
Coal } Woods Run	----	6	406	----
Shale, gray, clay	8	----	414	----
Shale, red and green, clay	5	----	419	----
Shale, gray, sandy	33	----	452	----
Shale, red and gray	4	----	456	----
Limestone, dark, fossiliferous, Pine Cr.	3	6	459	6
Shale, red and gray, clay	18	----	477	6
Sandstone	42	6	520	----
Slate, black	5	6	525	6
Shale, fossiliferous, Brush Creek	----	6	526	----
Coal	----	3	526	3
Shale, clay, with limestone	11	9	538	----
Shale, gray, clay	15	----	553	----
Sandstone	46	----	599	----
Shale, gray, sandy	12	----	611	----
Shale, dark, sandy	4	----	615	----
Coal, Upper Freeport (thickness confidential)	----	----	----	----
Fire clay	3	3	3	3

8. Drill-hole No. 1 on Hays Estate for L. B. and V. C. Hays, ½ mile south-southeast of B. M. 1081, near Terrace.

	Thickness		Total	
	Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 78				
Surface wash	6		6	
Shale, gray, sandy	31		37	
Sandstone	52		89	
Shale, soft, gray	5	6	94	6
Shale, gray	18	6	113	
Clay shale, red	34		147	
Clay shale, red and green	18		165	
Shale, gray	13		178	
Shale, gray, sandy	2		180	
Shale, dark	4	6	184	6
Coal, bony, Duquesne		3	184	9
Clay shale, soft	8	3	193	
Shale, gray, sandy	9	6	202	6
Clay shale, red	4	6	207	
Clay shale, soft, gray	9		216	
Clay shale, red	22		238	
Shale, light-colored, sandy, limy	30		268	
Clay shale, red	4		272	
Clay shale, gray	7		279	
Clay shale, red	5		284	
Shale, gray	8		292	
Clay shale, red and green	3	6	295	6
Shale, gray, sandy	28	6	324	
Shale, dark	13	6	337	6
Shale, dark, fossiliferous, Woods Run		6	338	
Coal		8	338	8
Clay shale, soft	11		349	8
Clay shale, red and green with lime	12	4	362	
Shale, gray, sandy	23		385	
Slate	7	6	392	6
Slate, fossiliferous, Pine Creek	2		394	6
Coal, bony		6	395	
Shale, gray, sandy	29		424	
Sandstone	27		451	
Slate	8	6	459	6
Shale, fossiliferous, Brush Creek	1		460	6
Coal		3	460	9
Clay shale, sandy	6	3	467	
Shale, gray, sandy	20		487	
Sandstone	44	6	531	6
Shale, gray, sandy	14		545	6
Shale, dark, sandy	10		555	6
Shale, dark		10	556	4
Coal, Upper Freeport (thickness confidential)				
Fire clay	2	10	2	10
Shale, gray, limy	9		11	10
Shale, gray, sandy	10	6	22	4
Slate, black		6	22	10
Shale, gray, sandy	13		35	10
Sandy	7		42	10
Slate	10		52	10
Slate, black	1		53	10
Coal, dirty, Lower Freeport		6	54	4
Fire clay, dark	4	6	58	10
Shale, gray, sandy	18		76	10
Sandstone	6		82	10
Slate	8		90	10
Coal, Upper Kittanning	1		91	10
Fire clay	5		96	10
Sandstone	54		150	10
Shale, dark, sandy	5		155	10
Slate	6		161	10
Coal, Middle Kittanning	3	3	165	1
Fire clay	7	3	172	4

9. Newfield Coke Company's drill-hole on the Wilson-Davidson farm ¼ mile south of B. M. 1206, between Verona and Unity Station.

	Thickness		Total	
	Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 119				
Surface	15		15	
Sandstone	15		30	
Shale, sandy	6		36	
Shale, black	9		45	
Shale, sandy	18		63	
Shale, soft	6		69	
Shale, dark	11		80	
Sandstone	26		106	
Shale, sandy	16		122	
Sandstone	3		125	
Shale, sandy	11		136	
Shale, dark	14	2	150	2
Coal, bony, Duquesne		7	150	9
Fire clay	4		154	9
Shale, soft	3	3	158	
Shale, green	5		163	
Shale, sandy	3		166	
Shale, green	2		168	
Shale, red	8		176	
Shale, green	1		177	
Shale, variegated	3		180	
Shale, sandy	5		185	
Shale, red	35		220	
Shale, light-colored	17		237	
Shale, black	21	11	258	11
Coal, bony, Bakerstown	1	2	260	1
Slate, black		8	260	9
Fire clay	5	3	266	
Shale, soft	10		276	
Shale, dark	25		301	
Sandstone	5		306	
Shale, black		6	306	6
Sandstone	7		313	6
Fire clay	12	6	316	
Shale, sandy	14		330	
Clay, black	6		336	
Shale, black	8		344	
Shale	20		364	
Sandstone	18		382	
Shale, sandy	16		398	
Shale, black	27		425	
Shale, sandy	12	10	437	10
Coal, Brush Creek		7	438	5
Fire clay	9	7	448	
Shale	10		458	
Shale, sandy	15		473	
Shale, black, Mahoning coal horizon	1		474	
Fire clay	3		477	
Shale, sandy	30		507	
Shale, black	1	6	508	6
Coal	1		509	6
Binder		3	509	9
Coal	2	4	512	1
Binder — Upper Freeport		4	512	5
Coal	3	½	515	5½
Binder		½	515	6
Coal		2	515	8
Binder		1	515	9
Coal		½	515	9½
Fire clay	4	2½	520	

Total depth 520 ft.

10. Drill-hole on the Catz farm, ⅓ mile northeast of B. M. 929 at Unity Station.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to tap of drill-hole 305					Shale, red and green	7	----	176	6
Surface	----	----	20	----	Shale, light-colored, sandy	22	----	198	6
Shale, red	7	----	27	----	Shale, dark, sandy	47	----	245	6
Shale, light-colored	23	----	50	----	Coal, Brush Creek	----	1	245	7
Shale, red	6	----	56	----	Fire clay, bastard	11	----	256	7
Shale, soft	5	----	61	----	Shale, red	2	5	259	----
Shale, sandy	14	----	75	----	Shale, sandy	3	----	262	----
Slate, dark	3	----	78	----	Soapstone	5	----	267	----
Coal ⎤	----	7	78	7	Shale, red	2	6	269	6
Bony } Bakers-	----	2	78	9	Shale, sandy	5	----	274	6
Coal ⎥ town	----	6	79	3	Shale, red and green	14	6	289	----
Coal and slate ⎦	----	7	79	10	Sandstone	35	----	324	----
Fire clay, bastard	14	6	94	4	Shale, dark, sandy	10	----	334	----
Shale, dark	1	8	96	----	Slate, dark	6	6	340	6
Shale, sandy	20	8	116	8	Coal	3	----	343	6
Sandstone	7	4	124	----	Coal, bony	1	----	344	6
Shale, dark, sandy	17	6	141	6	Coal ⎤	3	4½	347	10½
Shale, green	16	6	168	----	Slate } Upper Freeport	----	½	347	11
Sandstone, hard	1	6	169	6	Coal ⎦	----	10	348	9
					Fire clay	2	3	351	----
					Total depth 351 ft.				

11. Penn-Franklin Coal Company's drill-hole on the John Pahlman Heirs farm, ⅖ mile northwest of B. M. 1022, north of Universal.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 20					Coal, Bakerstown	1	5	349	5
Surface	18	----	18	----	Fire clay	3	7	353	----
Shale, limy	21	----	39	----	Shale, sandy	41	----	394	----
Shale, red	1	----	40	----	Sandstone	32	----	426	----
Shale, sandy	2	----	42	----	Shale, soft	2	----	428	----
Shale, red	4	----	46	----	Shale, red	12	----	440	----
Shale, sandy	43	----	89	----	Shale, soft	3	----	443	----
Shale, red	5	----	94	----	Shale, red	2	----	445	----
Shale, sandy	17	----	111	----	Shale, soft	3	----	448	----
Shale, red	38	----	149	----	Shale, sandy	8	----	456	----
Shale, sandy	17	----	166	----	Shale, red	2	----	458	----
Shale, red	35	----	201	----	Shale, sandy	31	----	489	----
Shale, sandy	36	----	237	----	Shale, black	68	----	557	----
Shale, black	12	2	249	2	Sandstone	53	----	610	----
Coal, Duquesne	----	7	249	9	Shale, black	4	10	614	10
Fire clay	4	3	254	----	Coal ⎤	2	7¼	----	----
Shale, sandy	6	----	260	----	Bone ⎥	----	10½	----	----
Shale, red	20	----	280	----	Coal ⎥	3	6	----	----
Shale, soft	9	----	289	----	Binder } Upper Freeport	----	¾	----	----
Shale, red	16	----	305	----	Coal ⎥	----	1¾	----	----
Shale, sandy	30	----	335	----	Binder ⎥	----	1⅛	----	----
Shale, red	12	----	347	----	Coal ⎦	----	4⅛	622	6⅞
Shale, black	1	----	348	----	Fire clay	3	5⅛	626	----
					Total depth 626 ft.				

12. Penn-Franklin Coal Company's drill-hole on the A. A. Miller farm at Center.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 170					Shale, blue	70	----	95	----
Casing	7	----	7	----	Shale, striped	8	----	103	----
Shale, red and green	9	----	16	----	Coal and bone, Duquesne	1	----	104	----
Coal, bony, Wellersburg	1	----	17	----	Shale, blue	16	----	120	----
Shale, red and green	8	----	25	----	Shale, red	20	----	140	----
					Shale, blue	6	----	146	----
					Shale, red	20	----	166	----

12. Penn-Franklin Coal Company's drill-hole—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Shale, blue	10		176		Fire clay	6	6	382	9
Shale, red	10		186		Shale, red	5		387	9
Shale, sandy	8		194		Shale, blue, limy	21	3	409	
Shale, red	9		203		Sandstone	75	10	484	10
Shale, blue	12		215		Slate		7	485	5
Fire clay, Bakerstown	4		219		Coal	1	6	486	11
Shale, blue	21		240		Bone		10¼	487	9¼
Sandstone	15		255		Coal	3	½	490	9¾
Shale, light-colored	20		275		Slate binder } Upper Freeport		1	490	10¾
Shale, blue	23		298		Coal		1¼	491	
Shale, limy, blue	20		318		Slate binder		1	491	1
Shale, sandy	22		340		Coal		10½	491	11½
Shale, dark	36	2	376	2	Fire clay		6½	492	6
Coal, Brush Creek		1	376	3	Total depth 492 ft. 6 in.				

13. Penn-Franklin Coal Company's drill-hole on the Johnson farm ½ mile E.-SE. of Center.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pitts-					Shale, blue	50		420	
burgh coal to top of drill-					Shale, sandy	15		435	
hole 60					Shale, dark	2		437	
Surface	15		15		Shale, blue, sandy	25		462	
Shale, blue	80		95		Shale, dark, sandy	50		512	
Shale, sandy	15		110		Coal, Brush Creek		5	512	5
Sandstone	10		120		Fire clay	8	7	521	
Shale, red	4		124		Shale, soft	17		538	
Shale, blue	20		144		Sandstone	16		554	
Shale, red	18		162		Shale, soft	7		561	
Shale, blue	25		187		Shale and sandstone	39	10	600	10
Shale, red	22		209		Slate, black	1	2	602	
Shale, blue	8		217		Coal	2	8	604	8
Shale, red	18		235		Bone		9	605	5
Shale, blue	20		255		Coal	3	2	608	7
Shale, red	30		285		Slate } Upper Freeport		½	608	7½
Shale, blue	15		300		Coal		1	608	8½
Shale, red	12		312		Slate		1	608	9½
Shale, blue	20		332		Coal		11	609	8½
Shale, red	15		347		Fire clay	1	1½	610	10
Shale, limy	20		367						
Shale, dark	3		370		Total depth 610 ft. 10 in.				

14. Penn-Franklin Coal Company's drill-hole on the William Pickford farm, ¾ mile south of Center.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pitts-					Shale, limy	7	3	139	
burgh coal to top of drill-					Shale, red	10		149	
hole 55					Shale, sandy	70		219	
Surface	8		8		Sandstone	1		220	
Shale, soft	12		20		Shale, sandy	5		225	
Sandstone	7	3	27	3	Shale, red and green	19	1	244	1
Fire clay	2	6	29	9	Shale, red	20		264	1
Shale, red	4		33	9	Limestone with fossils,				
Shale, sandy	9	6	43	3	Ames	3	4	267	5
Sandstone	6		49	3	Shale, red	27		294	5
Shale, sandy	4		53	3	Shale, light-colored	11		305	5
Shale, limy	9		62	3	Shale, red	8		313	5
Shale, red	15	2	77	5	Shale, light-colored	16		329	5
Shale, light-colored	12	2	89	7	Sandstone	8		337	5
Shale, sandy	42	2	131	9	Fire clay	14	7	352	

14. Penn-Franklin Coal Company's drill-hole—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Slate	1		353	
Coal, Bakerstown		1	353	1
Slate	1	8	354	9
Sandstone	15	9	370	6
Shale, dark	8	6	379	
Fire clay	4		383	
Shale, red	13		396	
Shale, sandy	26	8	422	8
Limestone, Pine Creek	1		423	8
Shale, limy	24		447	8
Shale, dark	26		473	8
Slate, sandy	20		493	8
Slate with fossils, Brush Creek	3		496	8
Coal		7	497	3
Fire clay	12	6	509	9
Shale, sandy	16		525	9
Shale, limy	22		547	9
Coal, Mahoning		7	548	4
Fire clay	9		557	4
Shale, sandy	27	11	585	3
Coal } Upper Freeport	5	3	590	6
Binder } Upper Freeport		1	590	7
Coal } Upper Freeport	1	1	591	8
Fire clay	1	8	593	4
Total depth 593 ft. 4 in.				

15. Drill-hole No. 1 of the Penn-Franklin Coal Coal Company on the Carothers Heirs farm, ⅝ mile north of B. M. 1196 near Clugston.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 83				
Surface	13		13	
Shale, red	40		53	
Shale, sandy	18		71	
Sandstone	2		73	
Shale, red	23		96	
Fire clay	8		104	
Shale, red	10		114	
Shale, light	73		187	
Coal, Duquesne		2	187	2
Fire clay	7		194	2
Shale, light-colored	6	6	200	8
Shale, red	33		233	8
Limestone with shells, Ames	4	6	238	2
Shale, red	37		275	2
Shale, sandy	14	6	289	8
Shale, dark	8		297	8
Sandstone	12		309	8
Shale, light-colored	4		313	8
Sandstone		6	314	2
Coal, Bakerstown		2	314	4
Slate	1	4	315	8
Limestone	2		317	8
Shale, sandy	11		328	8
Sandstone	15		343	8
Fire clay	2	8	346	4
Shale, light-colored	35		381	4
Sandstone	1		382	4
Shale, sandy	17		399	4
Shale, dark	26		425	4
Slate, sandy	27		452	4
Coal, Brush Creek		2	452	6
Fire clay	12		464	6
Shale, light-colored	21		485	6
Shale, sandy	25		510	6
Sandstone	4		514	6
Shale, sandy	29	5	543	11
Coal } Upper Freeport	2	8		
Coal, bony } Upper Freeport		10¾		
Coal } Upper Freeport	3	5		
Binder } Upper Freeport		½		
Coal } Upper Freeport		2		
Binder } Upper Freeport		¼		
Coal } Upper Freeport		9	551	10
Fire clay	1	4	553	2
Total depth 553 ft. 2 in.				

16. Drill-hole No. 2 of the Penn-Franklin Coal Company on the Carothers Heirs farm, ½ mile northeast of B. M. 1196 near Clugston.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 50				
Surface	15		15	
Limestone	2		17	
Shale, sandy	83		100	
Shale, light-colored	12		112	
Shale, soft	4		116	
Shale, light-colored, sandy	21		137	
Shale, soft	9		146	
Shale, sandy	14		160	
Shale, red	4		164	
Shale, soft	12		176	
Shale, sandy	38		214	
Shale, dark	5	8	219	8
Coal, Duquesne		7	220	3
Fire clay	4		224	3
Shale, soft	3	9	228	
Shale, sandy	4		232	
Shale, soft	4		236	
Shale, red	14		250	
Shale, dark	5		255	
Shale, red	25		280	
Clay, soft	7		287	
Shale, red	22		309	
Shale, sandy	16		325	
Shale, dark	12	8	337	8
Coal, Bakerstown		8	338	4

16. Drill-hole No. 2 of the Penn-Franklin Coal Company—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Fire clay	3	8	342	----
Shale, sandy	4	----	346	----
Sandstone	19	----	365	----
Sandstone, soft	12	----	377	----
Red stone	24	----	401	----
Sandstone	26	----	427	----
Red stone	9	----	436	----
Sandstone	39	----	475	----
Slate, black	21	2	496	2
Coal, Brush Creek	----	8	496	10
Shale, black	----	5	497	3
Fire clay	4	----	501	3
Shale, sandy	1	9	503	----
Shale, red	7	----	510	----
Shale, sandy	8	----	518	----
Shale, red	6	----	524	----
Shale, soft	12	----	536	----
Shale, sandy	12	----	548	----
Slate, black	10	2	558	2
Coal, Mahoning	1	9	559	11
Fire clay	2	1	562	----
Shale, sandy	29	----	591	----
Sandstone	1	4	592	4
Coal	----	9	----	----
Coal, bony	----	9¾	----	----
Coal	3	2¼	----	----
Binder	----	1	----	----
Coal	----	2	----	----
Binder	----	¾	----	----
Coal	----	10	598	2¾
Fire clay	2	9¼	601	----
Total depth 601 ft.				

17. Penn-Franklin Coal Company's drill-hole on the Shaw farm ¼ mile west by south of B. M. 1149 at Clugston.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Surface	----	----	30	----
Shale, soft	24	----	54	----
Sandstone	44	----	98	----
Shale, sandy	10	----	108	----
Shale, soft	9	----	117	----
Shale, red	6	----	123	----
Shale, sandy	5	----	128	----
Shale, soft	7	----	135	----
Shale, sandy	32	----	167	----
Shale, black	17	----	184	----
Coal, Duquesne	----	7	184	7
Fire clay	5	5	190	----
Shale, soft	10	----	200	----
Sandstone	4	----	204	----
Shale, red	8	----	212	----
Shale, soft	6	----	218	----
Shale, red	32	----	250	----
Shale, sandy	18	----	268	----
Shale, red	4	----	272	----
Shale, sandy	14	----	286	----
Sandstone	16	----	302	----
Coal, Bakerstown	----	7	302	7
Fire clay	4	----	306	7
Shale, sandy	6	5	313	----
Sandstone	38	----	351	----
Shale, black	14	----	365	----
Shale, sandy	27	----	392	----
Shale, soft	13	----	405	----
Shale, sandy	22	----	427	----
Shale, dark	33	----	460	----
Coal, Brush Creek	----	8	460	8
Fire clay	5	4	466	----
Shale, light-colored, sandy	45	----	511	----
Shale, dark	13	----	524	----
Coal, Mahoning	----	8	524	8
Fire clay	2	4	527	----
Shale, sandy	32	----	559	----
Shale, black	----	9	559	9
Coal } Upper Freeport	3	3	563	----
Slate } Upper Freeport	----	1½	563	1½
Coal } Upper Freeport	----	5½	563	7
Fire clay	1	5	565	----
Total depth 565 ft.				

18. Penn-Franklin Coal Company's drill-hole on the Carothers farm, ½ mile north of B. M. 1171, near Monroeville.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 182				
Surface	10	----	10	----
Shale, sandy	25	----	35	----
Shale, limy	2	----	37	----
Shale, red	12	----	49	----
Shale, green	9	----	58	----
Shale, sandy	24	----	82	----
Shale, dark	6	----	88	----
Coal, bony, Duquesne	----	6	88	6
Shale, light	22	6	111	----
Shale, sandy	2	----	113	----
Sandstone (Ames limestone)	3	----	116	----
Shale, red	20	----	136	----
Shale, limy	4	----	140	----
Shale, light colored	6	----	146	----
Shale, red	21	----	167	----
Shale, sandy	23	----	190	----
Shale, red	8	----	198	----
Shale, light	6	----	204	----
Shale, dark	7	----	211	----
Coal, bony, Bakerstown	1	7	212	7
Shale, light-colored	1	5	214	----
Shale, limy	3	----	217	----
Sandstone	10	----	227	----
Shale, sandy	14	----	241	----
Sandstone	22	----	263	----
Shale, variegated	5	----	268	----
Shale, sandy	4	----	272	----

18. Penn-Franklin Coal Company's drill-hole—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Shale, red	6	2	278	2	Shale, variegated	11	----	397	----
Shale, dark	2	8	280	10	Shale, green	9	----	406	----
Limestone, Pine Creek	2	6	283	4	Sandstone	26	----	432	----
Shale, red	3	8	287	----	Shale, dark	37	11	470	5
Shale, light-colored	2	----	289	----	Coal, bony, Upper Freeport	----	2½	470	7½
Shale, red	3	----	292	----	Shale, dark	1	4½	472	----
Shale, sandy	24	----	316	----	Shale, sandy	4	----	476	----
Limestone, Brush Creek (?)	2	----	318	----	Sandstone, coal partings	14	----	490	----
Shale, sandy	5	----	323	----	Sandstone, hard	4	4	494	4
Sandstone	9	----	332	----	Shale, light-colored, sandy	6	----	500	4
Shale, sandy	10	----	342	----	Shale, sandy	12	----	512	4
Shale, dark	30	----	372	----	Shale, light-colored	----	6	512	10
Coal, Brush Creek	----	6	372	6	Shale, dark	----	3	513	1
Fire clay	5	5	377	11	Fire clay	2	5	515	6
Shale, light-colored	8	1	386	----	Total depth 515 ft. 6 in.				

19. Penn-Franklin Coal Company's drill-hole on the William Beatty farm ⅖ mile northwest of B. M. 1196 near Clugston.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pitts-					Sandstone	9	----	303	----
burg coal to top of drill-					Shale, dark	7	----	310	----
hole 78					Shale, sandy	15	----	325	----
Surface	20	----	20	----	Sandstone	27	----	352	----
Sandstone	2	----	22	----	Shale, soft	22	----	374	----
Shale, dark	34	----	56	----	Shale, sandy	52	----	426	----
Shale, red	24	----	80	----	Shale, dark	44	8	470	8
Shale, light-colored, sandy	28	----	108	----	Coal, Brush Creek	----	3	470	11
Shale, red	10	----	118	----	Fire clay	3	1	474	----
Shale, soft	8	----	126	----	Shale, dark	39	----	513	----
Shale, red	4	----	130	----	Slate, black	9	6	522	6
Shale, sandy	48	----	178	----	Coal, Mahoning	----	4	522	10
Shale, black	16	----	194	----	Fire clay	4	2	527	----
Coal, Duquesne	----	4	194	4	Shale, sandy	25	----	552	----
Fire clay	3	----	197	4	Shale, black	13	8	565	8
Shale, sandy	4	8	202	----	Coal, dirty (Upper Freeport)	----	9½	566	5½
Shale, red	10	----	212	----	Coal (Upper Freeport)	2	3	----	----
Shale, sandy	4	----	216	----	Coal, bony (Upper Freeport)	----	8½	----	----
Shale, red	37	----	253	----	Coal (Upper Freeport)	3	4½	----	----
Shale, sandy	7	----	260	----	Binder (Upper Freeport)	----	¾	----	----
Shale, blue	20	----	280	----	Coal (Upper Freeport)	----	8½	573	6¾
Shale, red	7	----	287	----	Fire clay	1	5¼	575	----
Shale, sandy	7	----	294	----	Total depth 575 ft.				

20. Penn-Franklin Coal Company's drill-hole on the Robert Reiter farm ¾ mile east by south of B. M. 1107 at Universal.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pitts-					Shale, sandy	3	----	203	10
burgh coal to top of drill-					Shale, red	31	----	234	10
hole 88					Shale, light-colored	20	----	254	10
Surface	6	----	6	----	Shale, red	8	----	262	10
Shale, sandy	10	----	16	----	Shale, light-colored	12	----	274	10
Shale, red	45	----	61	----	Sandstone	12	----	286	10
Shale, sandy	26	----	87	----	Fire clay	8	----	294	10
Shale, red	18	----	105	----	Sandstone and shale	9	----	303	10
Shale, sandy	6	----	111	----	Shale, red	7	----	310	10
Shale, red	20	----	131	----	Shale, light-colored	37	----	347	10
Shale, sandy	41	----	172	----	Slate, black, Bakerstown				
Sandstone	5	4	177	4	coal horizon	1	2	349	----
Shale, sandy	5	6	182	10	Fire clay, sandy	1	6	350	6
Sandstone	18	----	200	10	Shale, sandy	21	6	372	----

20. Penn-Franklin Coal Company's drill-hole—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Shale, sandy	2	8	374	8	Shale, sandy	10	4	496	6
Limestone, Pine Creek	1	4	376		Sandstone	59		555	6
Shale, red	8		384		Coal, bony		4	555	10
Sandstone and shale	23		407		Coal	2	7¼		
Shale, dark	19		426		Binder		1½		
Slate	14		440		Coal	3	2		
Coal, Brush Creek		2	440	2	Binder } Upper Freeport				
Fire clay	6		446	2	Coal		2		
Shale, red	16		462	2	Binder		¾		
Fire clay	4		466	2	Coal		11	562	11½
Shale, red	2		468	2	Fire-clay	2	7½	565	7
Shale, sandy	12		480	2					
Shale, red	6		486	2	Total depth 565 ft. 7 in.				

21. Penn-Franklin Coal Company's drill-hole on the M. Reiter farm, ⅗ mile southeast of B. M. 1160 near Universal.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 80					Shale, blue	4		473	
Surface			8		Sandstone	2		475	
Shale, red and blue	132		140		Shale, blue	8		483	
Shale, sandy	45		185		Clay, bastard, and shale	8		491	
Shale, dark	31		216		Sandstone	35	2	526	2
Coal bony	1		217		Shale, dark	1	6	527	8
Shale, blue	65		282		Sandstone	5		532	8
Sandstone	6		288		Shale	3	6	536	2
Shale, blue	30		318		Sandstone	12	6	548	8
Shale, sandy	16		334		Shale, black	1	4	550	
Sandstone	6		340		Coal, cannel	1	11	551	11
Slate, dark	2		342		Coal	2	½	553	11½
Shale, sandy	10		352		Coal, bony		10	554	9½
Shale, blue	20		372		Coal } Upper Freeport	2	10	557	7½
Shale, sandy	44		416		Slate band		½	557	8
Shale, black	36		452		Coal		1¾	557	9¾
Shale, bony, Brush Creek		6	452	6	Slate band		1	557	10¾
Clay, bastard	10		462	6	Coal		8½	558	7¼
Shale, red	6	6	469		Fire clay	2	9¾	561	5
					Total depth 561 ft. 5 in.				

22. Penn-Franklin Coal Company's drill-hole on the Tillford Estate, ½ mile S-SE. of B. M. 1107 at Universal.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 10					Shale, red	20		220	
Surface & cave (Pgh. coal)	32		32		Shale, light-colored	14		234	
Limestone	5		37		Shale, sandy	24		258	
Shale, limy	7		44		Shale, dark	6	2	264	2
Shale, red	10		54		Coal, Duquesne		4	264	6
Shale, limy	9		63		Fire clay and shale	6	6	271	
Shale, sandy	8		71		Sandstone	6		277	
Shale, red	30		101		Shale, variegated	15		292	
Shale, sandy	6		107		Shale, limy	5		297	
Shale, red	10		117		Shale, red	27		324	
Shale, light-colored	8		125		Shale, sandy	10		334	
Shale, red	31		156		Shale, green	9		343	
Shale, sandy	12		168		Shale, light-colored	7		350	
Shale, light-colored	10		178		Shale, variegated	4		354	
Shale, red	15		193		Shale, dark	13		367	
Shale, light-colored	7		200		Coal, bony, Bakerstown	1	11	368	11
					Shale, light-colored	1	1	370	
					Shale, sandy	11		381	

22. Penn-Franklin Coal Company's drill-hole—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Sandstone	24		405	
Shale, dark	32		437	
Shale, green	20		457	
Shale, limy, Pine Creek	1		458	
Shale, light-colored	2		460	
Sandstone	25		485	
Shale, dark	39		524	
Coal, Brush Creek		3	524	3
Fire clay, shaly	4	9	529	
Shale, limy	4		533	
Shale, light-colored	12		545	
Shale, sandy	46		591	
Sandstone	19	6	610	6
Shale, light-colored	1		611	6
Sandstone	14	1	625	7
Slate		5	626	
Coal	2	8	628	8
Binder		¼	628	8¼
Coal — Upper Freeport		1¾	628	10
Binder		1	628	11
Coal		3½	629	2½
Fire clay	3	5½	632	8

Total depth 632 ft. 8 in.

23. Drill-hole on the Joseph Stotler farm, 7/10 of a mile west of B. M. 1065 at Universal.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 139				
Surface	36		36	
Shale, rotten	22		58	
Fire clay, red	15		73	
Shale, green	20		93	
Shale, sandy	30		123	
Slate, dark	8		131	
Coal, Duquesne		8	131	8
Fire clay	20		151	8
Fire clay, red	38		189	8
Shale, light-colored	30		219	8
Shale, red	10		229	8
Slate, black	2		231	8
Coal, bony, Bakerstown		4	232	
Fire clay	18		250	
Shale, sandy	40		290	
Fire clay and shale, hard	10		300	
Soapstone	7		307	
Shale, sandy	22		329	
Soapstone	5		334	
Limestone, Pine Creek	2		336	
Fire clay	1		337	
Sandstone	23		360	
Shale, bastard	24		384	
Shale, sandy	8		392	
Slate, dark	14		406	
Sandstone	2		408	
Coal, Brush Creek		4	408	4
Slate, dark		6	408	10
Fire clay	19		427	10
Shale, dark	21		448	10
Limestone, bastard	10		458	10
Shale, dark	6		464	10
Sandstone, hard	6		470	10
Sandstone and shale	29	2	500	
Shale, dark	6		506	
Slate, dark		6	506	6
Bony		3	506	9
Coal	3		509	9
Binder — Upper Freeport		1	509	10
Coal		1½	509	11½
Binder		1	510	½
Coal		2	510	2½
Fire clay	3	9½	514	

Total depth 514 ft.

24. Drill-hole No. 2 of the Westinghouse Electric & Manufacturing Company at Bessemer Station (Port Perry) on the B. & O. R.R.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 280				
Surface	7		7	
Sandstone	2		9	
Shale, yellow	3		12	
Limestone, Ames	2		14	
Shale, red	60		74	
Shale, green	6		80	
Shale, red and green	30		110	
Shale, sandy	6		116	
Shale, red	35		151	
Shale, green	10		161	
Shale, red	6		167	
Shale, sandy	6		173	
Shale, red	3		176	
Shale, green	39		215	
Slate, dark	4	6	219	6
Coal		6	220	
Shale and fire-clay	17		237	
Shale, sandy	13		250	
Coal		8	250	8
Fire clay	2	4	253	
Sandstone	8		261	
Slate, dark	22		283	
Coal, Brush Creek		6	283	6
Fire clay	3	6	287	
Shale, green	8		295	

24. Drill-hole No. 2 of the Westinghouse Electric & Manufacturing Company—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Sandstone	8		303	
Shale, green	5		308	
Fire clay	5		313	
Sandstone	52		365	
Shale, sandy	4		369	
Slate, black	1		370	
Sandstone	2		372	
Shale, sandy	3		375	
Slate, black	3		378	
Upper Freeport: Coal	1	8	379	8
Upper Freeport: Coal, bony		4	380	
Upper Freeport: Coal	1		381	
Upper Freeport: Coal, bony		10	381	10
Upper Freeport: Coal	3	4½	385	2½
Upper Freeport: Slate		1	385	3½
Upper Freeport: Coal		9½	386	1
Fire clay	1	8	387	9
Total depth 387 ft. 9 in.				

25. Drill-hole No. 5 of the Westinghouse Electric & Manufacturing Company on the James H. Moore farm, $\frac{3}{5}$ mile northwest by north from B. M. 1226 near East McKeesport.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 156				
Surface	13		13	
Shale, sandy	6	6	19	6
Shale, red	2	6	22	
Sandstone	12	6	34	6
Shale, red	44		78	6
Shale, sandy	1	6	80	
Shale, red	4	6	84	6
Shale, sandy	20		104	6
Shale, dark	3		107	6
Coal, bony, Duquesne		6	108	
Fire clay	7	6	115	6
Sandstone	2	6	118	
Shale, sandy	5	6	123	6
Shale, red	5	6	129	
Shale, variegated	7	6	136	6
Limestone, bastard, Ames	2	8	139	2
Shale, variegated	2	4	141	6
Shale, red	22		163	6
Shale, green	18		181	6
Shale, red	23		204	6
Shale, green	12		216	6
Shale, red	5		221	6
Shale, green	4		225	6
Shale, green	6		231	6
Shale, sandy	11		242	6
Shale, dark	6		248	6
Limestone, bastard, Woods Run	1	4	249	10
Coal, bony		8	250	6
Fire clay	2		252	6
Shale, red	23		275	6
Shale, sandy	38		313	6
Shale, dark	2	8	316	2
Coal, bony, Pine Creek		4	316	6
Fire clay	10		326	6
Shale, sandy	6		332	6
Sandstone	46		378	6
Slate, black	8		386	6
Coal, bony, Brush Creek		8	387	2
Fire clay	7	4	394	6
Fire clay, sandy	1		395	6
Shale, variegated	6		401	6
Fire clay, sandy	18		419	6
Fire clay	6		425	6
Sandstone	57		482	6
Slate, black	5	4	487	10
Upper Freeport: Coal, dirty		3¾	488	1¼
Upper Freeport: Shale		1¼	488	2½
Upper Freeport: Coal, dirty		1½	488	4
Upper Freeport: Coal	3	3	491	7
Upper Freeport: Coal, high ash		8	492	3
Upper Freeport: Coal, bony		4	492	7
Upper Freeport: Coal	3	8	496	3
Upper Freeport: Slate		¼	496	3¼
Upper Freeport: Coal		2	496	5¼
Upper Freeport: Slate		½	496	5¾
Upper Freeport: Coal		2½	496	8¼
Shale and clay	2	7¼	499	3½
Total depth 499 ft. 3½ in.				

26. Drill-hole No. 4 of the Westinghouse Electric & Manufacturing Company, near Pitcairn St., Wilmerding, and 1,000 feet west of the Pennsylvania Railroad station.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 274				
Surface	50		50	
Shale, green and red	20		70	
Shale, green	10		80	
Shale, red	12		92	
Shale, green	20		112	
Shale, red	5		117	
Shale, green	20		137	
Fire clay	6		143	
Shale, red	12		155	
Shale, sandy	35		190	
Sandstone	50		240	
Shale, dark	9		249	
Fire clay	5		254	
Shale, soft	43		297	
Sandstone	58		355	
Slate, black	1		356	
Upper Freeport: Coal, bony		10	356	10
Upper Freeport: Coal	3		359	10
Fire clay	2		361	10
Total depth 361 ft. 10 in.				

27. Westinghouse Electric and Manufacturing Company's drill-hole on the James White farm, ⅓ mile west by south from B. M. 1226, near East McKeesport.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Surface	15	----	15	----
Sandstone	12	----	27	----
Shale	2	----	29	----
Coal, Pittsburgh	22	----	51	----
Fire clay	4	----	55	----
Shale, sandy	15	----	70	----
Shale, dark	1	----	71	----
Limestone	2	----	73	----
Shale, light-colored	1	----	74	----
Shale, sandy	4	----	78	----
S[illegible]my	10	----	88	----
Limestone	5	----	93	----
Shale, limy	3	----	96	----
Limestone	3	----	99	----
Shale, limy	6	6	105	6
Limestone	2	----	107	6
Shale, limy	8	----	115	6
Shale, red	3	----	118	6
Shale, limy	8	----	126	6
Limestone	3	----	129	6
Shale, limy	1	----	130	6
Shale, red	13	----	143	6
Shale, light-colored	4	----	147	6
Shale, limy	1	----	148	6
Shale, red	10	----	158	6
Shale, limy	2	----	160	6
Limestone, Clarksburg	1	----	161	6
Shale, limy	1	----	162	6
Sandstone	4	----	166	6
Shale, limy	4	6	171	----
Shale, red	17	6	188	6
Shale, limy	20	----	208	6
Shale, sandy	30	----	238	6
Shale, limy	5	----	243	6
Shale, red	48	----	291	6
Shale, limy	18	----	309	6
Shale, dark	5	----	314	6
Coal, bony, Duquesne	----	6	315	----
Fire clay	9	6	324	6
Shale	9	6	334	----
Shale, red	80	----	414	----
Shale, blue	40	----	454	----
Shale, red	10	----	464	----
Shale, blue	20	----	484	----
Shale, red	10	----	494	----
Shale, blue	32	----	526	----
Sandstone	43	----	569	----
Shale, dark	25	8	594	8
Coal, Brush Creek	----	4	595	----
Shale, blue, and clay	10	----	605	----
Shale, blue	14	----	619	----
Sandstone	6	----	625	----
Shale, soft	6	----	631	----
Shale, red	15	----	646	----
Shale, sandy	14	----	660	----
Sandstone	18	----	678	----
Shale, sandy	14	6	692	6
Shale, dark	4	5	696	11
Coal	----	2	697	1
Slate	----	3	697	4
Coal	2	8	700	----
Coal, bony	----	8	700	8
Coal } Upper Freeport	----	6½	701	2½
Coal, bony	----	1	701	3½
Coal	3	2	704	5½
Slate	----	1¼	704	6¾
Coal	----	11¼	705	6
Clay	4	1	709	7
Total depth 709 ft. 7 in.				

28. Drill-hole No. 6 of the Westinghouse Electric & Manufacturing Company on the Bowman farm, ⅜ mile W-SW. of B. M. 1242 near East McKeesport.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 105				
Surface	6	----	6	----
Shale, red	14	----	20	----
Sandstone	6	----	26	----
Shale, red	34	----	60	----
Shale, sandy	5	9	65	9
Shale, red	9	----	74	9
Shale, sandy	12	----	86	9
Shale, red	21	----	107	9
Shale, dark	2	----	109	9
Shale, red	32	----	141	9
Shale, sandy	20	----	161	9
Shale, black	2	----	163	9
Coal, bony, Duquesne	1	----	164	9
Fire clay	6	----	170	9
Shale, red	1	----	171	9
Sandstone	8	----	179	9
Shale, sandy	2	----	181	9
Shale, red	12	----	193	9
Shale, limy, Ames	5	----	198	9
Shale, soft	4	----	202	9
Shale, red	13	----	215	9
Shale, light-colored	20	----	235	9
Shale, red	26	----	261	9
Shale, light-colored	21	6	283	3
Shale, sandy	10	6	293	9
Shale, dark	13	6	307	3
Fire clay	1	6	308	9
Shale, red	15	----	323	9
Shale, light-colored	20	----	343	9
Shale, dark	10	----	353	9
Limestone, bastard, Pine Creek	2	----	355	9
Shale, sandy	35	----	390	9
Sandstone	47	----	437	9
Coal, bony, Brush Creek	----	8	438	5
Fire clay	2	4	440	9
Shale, limy	2	----	442	9
Shale, red	9	----	451	9
Shale, sandy	8	----	459	9
Shale, red	9	----	468	9
Clay, soft	8	----	476	9
Shale, sandy	35	----	511	9
Shale, dark	3	2	514	11
Coal, bony	----	4	515	3
Shale	1	5	516	8
Shale, clay	----	6	517	2
Coal	----	5½	517	7½
Slate	----	1½	517	9
Coal	2	6½	520	3½
Coal, bony	----	9	521	½
Coal } Upper Freeport	3	1	524	1½
Slate	----	½	524	2
Coal	----	3½	524	5½
Fire clay	----	1	524	6½
Coal	----	4½	524	11
Fire clay	2	2	527	1
Shale, sandy	1	8	528	9
Total depth 528 ft. 9 in.				

29. Drill-hole No. 3 of the Westinghouse Electric& Manufacturing Company on the Wilmerding Land Company farm, ½ mile southeast of B. M. 1057, north of McKeesport.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 227					Shale, dark	7	—	237	—
Surface	13	—	13	—	Limestone, bastard, Pine Creek	1	4	238	4
Shale, sandy	30	8	43	8	Coal, bony	—	8	239	—
Coal, bony, Duquesne	—	4	44	—	Fire clay	2	—	241	—
Fire clay	6	—	50	—	Shale, sandy	27	—	268	—
Shale, sandy	1	4	51	4	Sandstone	41	—	309	—
Sandstone	7	8	59	—	Shale, dark	1	—	310	—
Shale, sandy	1	—	60	—	Coal, bony, Brush Creek	—	4	310	4
Shale, red	7	4	67	4	Fire clay	1	8	312	—
Shale, variegated	3	4	70	8	Shale, limy	2	—	314	—
Limestone, bastard, Ames	2	2	72	10	Shale, red	2	—	316	—
Shale, dark	1	2	74	—	Shale, variegated	3	—	319	—
Shale, soft	5	—	79	—	Shale, dark	1	6	320	6
Shale, red	6	—	85	—	Fire clay, sandy	12	6	333	—
Shale, variegated	5	—	90	—	Fire clay	5	—	338	—
Shale, green	25	—	115	—	Shale, sandy	9	6	347	6
Shale, red	5	—	120	—	Sandstone	9	6	357	—
Shale, variegated	13	—	133	—	Sandstone	39	6½	396	6½
Shale, green	12	—	145	—	Shale, dark	—	11½	397	6
Shale, variegated	3	—	148	—	Coal, bony (Upper Freeport)	—	5½	397	11½
Shale, green	29	—	177	—	Coal (Upper Freeport)	1	1½	399	1
Shale, dark	9	—	186	—	Coal, bony (Upper Freeport)	—	9½	399	10½
Fire clay	1	3	187	3	Coal (Upper Freeport)	2	3½	402	2
Shale, variegated	—	9	188	—	Binder (Upper Freeport)	—	½	402	2½
Shale, green	2	—	190	—	Coal (Upper Freeport)	1	2½	403	5
Shale, red	12	—	202	—	Fire clay	2	6½	405	11½
Shale, sandy	28	—	230	—	Total depth 405 ft. 11½ in.				

30. Drill-hole No. 13 of the McKeesport Coal & Coke Company, ½ mile N-NW. of B. M. 911 near Portvue.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 260					Shale, blue	33	—	290	—
Surface	9	—	9	—	Coal, Brush Creek	1	—	291	—
Shale, variegated	135	—	144	—	Clay	7	—	298	—
Shale, blue	28	—	172	—	Shale and clay	26	—	324	—
Sandrock	51	—	223	—	Shale, broken, sandy	28	—	352	—
Slate	15	—	238	—	Sandrock, broken	27	6	379	6
Coal, Pine Creek	—	8	238	8	Coal, Upper Freeport (thickness confidential)	—	—	—	—
Clay	3	4	242	—	Clay	6	2	6	2
Shale, variegated	15	—	257	—	Shale, sandy and limy	18	—	24	2
					Sandrock, hard	21	—	45	2

31. Drill-hole No. 11 of the McKeesport Coal & Coke Company on the Geiss property, ½ mile N-NW. of B. M. 815 at the junction of Long Run and Jacks Run, Versailles township.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 320					Sandstone	86	—	210	—
Surface	9	—	9	—	Shale, light-colored	6	—	216	—
Shale, green	30	—	39	—	Shale, green	31	—	247	—
Shale, red	5	—	44	—	Sandstone	48	—	295	—
Shale, green	22	—	66	—	Shale, light-colored	14	—	309	—
Shale, dark	9	—	75	—	Slate, black	5	8	314	8
Shale, red	21	—	96	—	Coal, Upper Freeport (thickness confidential)	—	—	—	—
Shale, green	28	—	124	—	Fire clay	—	6	6	—

32. Drill-hole No. 10 of the McKeesport Coal & Coke Company on the Bowman farm, 500 feet southeast of B. M. 917 near McKeesport.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgb coal to top of drill-bole 213					Sand rock, broken	62	6	334	6
					Coal, Brush Creek		6	335	
					Clay	5		340	
Surface	5		5		Shale, variegated	24		364	
Shale, variegated	43		48		Shale, blue	25	4	389	4
Shale, blue	14		62		Coal, Maboning		8	390	
Coal, Duquesne		6	62	6	Clay	5		395	
Clay	7	6	70		Limestone and sbale	30	8	425	8
Shale, variegated	111		181		Slate	2		427	8
Shale, green	4		185		Coal, Upper Freeport (thickness confidential)				
Shale, variegated	42		227						
Shale, blue	45		272		Fire clay	2	2½	2	2½

33. Drill-hole No. 5 of the McKeesport Coal & Coke Company on the Stark (Storch?) farm, ⅜ mile S-SW. of B. M. 917 near McKeesport.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgb coal to top of drill-hole 160					Fire-clay	1	6	234	6
					Shale, variegated	13		247	6
					Shale, green	20	6	268	
Surface	26		26		Sandrock	21		289	
Sandrock, soft	9		35		Shale and clay	13		302	
Shale, variegated	78		113		Shale, limy	39	6	341	6
Slate	1		114		Shale, variegated	2	6	344	
Coal, Duquesne		8	114	8	Clay and shale, soft	23	6	367	6
Fire-clay	1	4	116		Clay, bard, sandy	32	6	400	
Shale, green	64		180		Shale, dark	28	2	428	2
Sandrock	46		226		Sandstone		4	428	6
Shale, blue	6	6	232	6	Coal, Mahoning		10	429	4
Coal		6	233		Fire clay	3	2	432	6

34. Drill-hole No. 8 of the McKeesport Coal & Coke Company on the Haler farm 1 mile E-NE. of the mouth of Long Run.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 215					Shale, limy	3	4	247	
					Sandrock, hard	28		275	
					Sandrock	37		312	
Surface	20		20		Slate	13		325	
Sandrock, broken	39		59		Coal, Brush Creek		8	325	8
Coal, Duquesne		8	59	8	Clay	7	4	333	
Fire clay	4	4	64		Shale, variegated	8		341	
Shale, variegated	101		165		Shale, green	14		355	
Shale, hard, limy	23		188		Shale, sandy	17		372	
Slate	4		192		Clay, shaly	16		388	
Coal, Woods Run		4	192	4	Sandrock and shale	29	2	417	2
Clay	6	8	199		Slate		10	418	
Shale, variegated	18		217		Coal, Upper Freeport (thickness confidential)				
Shale, hard, limy	18		235						
Shale, limy	7		242		Fire clay	2	4½	2	4½
Limestone, Pine Creek	1	8	243	8					

35. Drill-hole No. 14 of the McKeesport Coal & Coke Company at the site of their Hubbard shaft at Versailles.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 450					Sandstone	2	....	126	....
Surface	15	....	15	....	Shale, sandy	6	....	132	....
Sandstone	74	6	89	6	Sandstone	42	6	174	6
Shale, dark	6	4	95	10	Shale, sandy	7	2	181	8
Coal, Brush Creek	....	6	96	4	Shale, dark	....	8	182	4
Fire clay	2	6	98	10	Coal, Upper Freeport (thickness confidential	....	....	......	....
Shale, soft, light-colored	10	2	109	....	Binder	....	1	......	1
Shale, sandy, with shale streaks	15	....	124	....	Coal	....	7	......	8
					Fire clay	1	....	1	8
					Shale	3	4	5	....

36. Drill-hole No. 2 of the McKeesport Coal & Coke Company on the Hamilton farm, ⅝ mile E-SE. of the mouth of Long Run.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 490					Shale, green	6	10	101	10
Surface	6	9	6	9	Sandrock	37	11	139	9
Sandrock	13	8	20	5	Slate	....	7	140	4
Shale, dark	20	3	40	8	Coal, Upper Freeport (thickness confidential)	....	....	......	....
Slate	7	4	48	....	Fire clay	1	8	1	8
Coal, Brush Creek	....	6	48	6	Shale, green	20	9	22	5
Shale, green	13	6	62	....	Shale, limy	2	10	25	3
Sandrock	31	1	94	1	Shale, green, with limy shale streaks	18	2	43	5
Shale, dark	....	11	95	....					

37. Drill-hole No. 3 of the McKeesport Coal & Coke Company, near the center of Olympia Park, Versailles.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 400					Slate	....	4	152	9
Surface	22	....	22	....	Shale	13	....	165	9
Shale, red and green	23	1	45	1	Shale, red	8	7	174	4
Shale, green	22	....	67	1	Sandrock	49	1	223	5
Shale, blue	13	4	80	5	Shale	5	4	228	9
Sandrock	51	5	132	10	Slate	4	....	232	9
Slate	19	2	152	....	Coal, Upper Freeport (thickness confidential)	....	....	......	....
Coal, Brush Creek	....	5	152	5	Fire clay	1	....	1	....

38. Drill-hole sunk for Clark, Flint and Wessel near B. M. 793, near Boston. (Accuracy doubted).

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 242					Shale, sandy	19	6	263	6
Surface	12	----	12	----	Sandstone	22	3	285	9
Shale, green	26	----	38	----	Fire clay	4	4	290	1
Sandstone	52	----	90	----	Limestone	2	6	292	7
Shale, sandy	1	----	91	----	Fire clay	4	5	297	----
Sandstone	18	----	109	----	Shale, sandy	3	----	300	----
Shale, sandy	12	6	121	6	Shale, black	----	2	300	2
Coal	1	----	122	6	Shale, sandy	13	----	313	2
Fire clay	6	----	128	6	Shale, black	2	----	315	2
Shale, gray	3	----	131	6	Shale, sandy	11	6	326	8
Shale, red and green	7	----	138	6	Shale, black	2	----	328	8
Shale, green	35	----	175	6	Shale, sandy	10	----	338	8
Sandstone	30	6	206	----	Sandstone	2	----	340	8
Shale, sandy	4	2	210	2	Limestone	1	4	342	----
Shale, black	----	3	210	5	Shale, sandy	47	----	389	----
Coal	1	6	211	11	Shale, black	4	----	393	----
Shale	----	1	212	----	Coal, Upper Freeport	4	----	397	----
Coal	----	2	212	2	Fire clay	2	----	399	----
Shale, sandy	14	----	226	2	Limestone	----	3	399	3
Limestone	6	4	232	6	Fire clay	8	4	407	7
Sandstone	1	----	233	6	Shale, black	1	----	408	7
Limestone	1	----	234	6	Bone	7	5	416	----
Shale, sandy	8	----	242	6	Sandstone, crystalized	9	----	425	----
Limestone	1	6	244	----	Sandstone	1	----	426	----
					Total depth 426 ft.				

39. Drill-hole No. 6 of the McKeesport Coal & Coke Company, ⅝ mile SW. of B. M. 881 in the SE. part of Versailles township.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 377					Limestone, fossiliferous, Brush Creek	1	----	161	----
Surface	52	----	52	----	Coal, Brush Creek	----	4	161	4
Boulders	6	----	58	----	Clay	10	----	171	4
Gravel	4	----	62	----	Shale, red	11	----	182	4
Shale, green	5	----	67	----	Shale and limestone	21	----	203	4
Limestone, Woods Run (?)	1	----	68	----	Shale, limy	12	----	215	4
Shale, red	24	----	92	----	Shale, limy	31	----	246	4
Shale, blue	5	----	97	----	Sandstone	11	6	257	10
Sandstone	26	----	123	----	Coal, Upper Freeport (thickness confidential)	----	----	----	----
Slate and limestone	37	----	160	----	Fire clay	2	6	2	6

40. Drill-hole No. 12 of the McKeesport Coal & Coke Company, on the line between the McClintock and Hayden properties and ⅝ mile NE. of B. M. 881 in the SE. part of Versailles township.

	Thickness		Total			Thickness		Total	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
Interval from base of Pittsburgh coal to top of drill-hole 217					Sandrock	59	----	328	----
Gravel and boulders	9	----	9	----	Slate	5	4	333	4
Shale, blue	26	----	35	----	Coal, Brush Creek	----	8	334	----
Sandrock, broken	10	----	45	----	Clay	6	----	340	----
Shale, blue	12	6	57	6	Shale, variegated	15	----	355	----
Coal, Duquesne	----	8	58	2	Shale, light-colored	12	----	367	----
Clay	11	10	70	----	Shale, light-colored	55	----	422	----
Shale, variegated	158	----	228	----	Sandrock	16	----	438	----
Shale, green	15	----	243	----	Shale, blue, sandy	5	9	443	9
Shale, blue	26	----	269	----	Coal, Upper Freeport (thickness confidential)	----	----	----	----
					Fire clay	2	7	2	7

41. Drill-hole No. 9 of the McKeesport Coal & Coke Company, on the line between the Miller and Hayden properties ⅓ mile SE. of B. M. 881 in the SE. part of Versailles township.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 117					Shale, blue	37		288	7
Surface	12		12		Shale, dark	7		295	7
Shale, red	12		24		Coal, Woods Run		2	295	9
Shale, light-colored	11		35		Clay	6		301	9
Shale, red	20		55		Shale, red	19		320	9
Shale, light-colored	18		73		Shale	22		342	9
Shale, red	40		113		Shale, red	34		376	9
Shale	15		128		Sandstone	35		411	9
Shale, red	9		137		Slate	24		435	9
Shale	2		139		Shale, fossiliferous } Brush		9	436	6
Sandstone	6		145		Coal } Creek		6	437	
Shale	7		152		Fire clay and limestone	8		445	
Slate	10	6	162	6	Limestone and shale	12		457	
Coal, Duquesne		8	163	2	Sandstone	11		468	
Fire clay and shale	12		175		Shale, sandy and limy	22		490	
Shale, red	4		179	2	Coal, Mahoning		6	490	6
Shale, green	8		187	2	Clay	9		499	6
Limestone, fossiliferous, Ames	6		193	2	Shale, limy	26		525	6
Coal, Harlem		5	193	7	Sandstone	1	10	527	4
Fire clay	6		199	7	Coal, Upper Freeport (thickness confidential)				
Shale, red	52		251	7	Fire clay	3	5	3	5

42. Drill-hole No. 7 of the McKeesport Coal & Coke Company on the Keeler farm, ⅜ mile south by west from B. M. 881 in the SE. part of Versailles township.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 328					Slate	12	6	214	9
Surface	44		44		Slate, fossiliferous } Brush		6	215	3
Boulders	1	6	45	6	Coal } Creek		5	215	8
Shale, blue	21	6	67		Fire clay	6	6	222	2
Shale, dark	6		73		Clay and limestone	11		233	2
Limestone } Woods Run	1		74		Shale, variegated	8		241	2
Coal }		1	74	1	Shale, limy	20		261	2
Clay	3		77	1	Fire clay	7		268	2
Shale, red	20		97	1	Shale, limy	35		303	2
Shale, sandy	31		128	1	Coal		8	303	10
Sandstone	64		192	1	Shale, sandy	2	10	306	8
Shale, sandy	1	2	193	3	Sandstone	1	6	308	2
Sandstone	3		196	3	Coal, Upper Freeport (thickness confidential)				
Sandstone	6		202	3	Fire clay	2	7½	2	7½

43. Drill-hole sunk for Clark, Flint and Wessel, at Greenock.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Interval from base of Pittsburgh coal to top of drill-hole 212					Shale, red and green	1		74	
Surface	40	6	40	6	Shale, green	4		78	
Shale, gray	4		44	6	Shale, red	2		80	
Shale, sandy	14	6	59		Shale, green	12		92	
Coal, Duquesne		10	59	10	Shale, limy, Ames horizon	5	6	97	6
Fire clay	4	2	64		Coal, Harlem		6	98	
Shale, green	4	9	68	9	Fire clay	3		101	
Shale, red	1	1	69	10	Shale, green	6		107	
Shale, green	3	2	73		Shale, red and green	13		120	
					Shale, red	10		130	
					Shale, green	7		137	

43. Drill-hole sunk for Clark, Flint and Wessel—Concluded.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Shale, red	3		140		Slate, sandy	34	9	475	
Shale, green	14		154		Shale, gray	15		490	
Shale, red		6	154	6	Sandstone	5	4	495	4
Shale, green	1		155	6	Shale	4	8	500	
Shale, red	3		158	6	Slate, sandy	12	6	512	6
Shale, green	53	6	212		Sandstone		6	513	
Shale, sandy	32		244		Slate, sandy	11	4	524	4
Shale, red	6		250		Slate, black, Lower Freeport horizon	2		526	4
Shale, green	4		254						
Shale, gray	5	6	259	6	Fire clay	2	2	528	6
Sandstone	41	6	301		Shale, gray	15	6	544	
Slate, sandy	24	6	325	6	Sandstone	7		551	
Coal, Brush Creek		6	326		Shale	4		555	
Slate	1		327		Sandstone	3		558	
Fire clay	6		333		Slate, sandy	6		564	
Shale, red	7		340		Slate, black		7	564	7
Shale, green	21		361		Coal, Upper Kittanning		1	564	8
Sandstone	1		362		Slate	1	3	565	11
Slate, sandy	11	2	373	2	Sandstone	1	8	567	7
Coal, Mahoning	1	5	374	7	Slate	30	3	597	10
Slate		2	374	9	Coal, Middle Kittanning	4	2	602	
Fire clay	6		380	9	Slate		2	602	2
Shale, sandy	10	3	391		Fire clay	4		606	2
Sandstone	6	4	397	4	Sandstone	6	10	613	
Slate, sandy		6	397	10	Slate, sandy	6	3	619	3
Sandstone	18	2	416		Sandstone		6	619	9
Slate, sandy	2		418		Slate, sandy	12	3	623	
Sandstone	19		437		Slate	9	6	641	6
Limestone } Upper Freeport	1		438		Coal, Lower Kittanning	1	6	643	
Sandstone } Upper Freeport		3	438	3	Fire clay	19		662	
Limestone } Upper Freeport	1		439	3	Shale, gray	1		663	
Sandstone	1		440	3	Total depth 663 ft.				

44. Westmoreland Coal Company's drill-hole at Rillton, about 2 miles east of Yohogany, Sewickley township.

	Thickness Ft.	Thickness In.	Total Ft.	Total In.		Thickness Ft.	Thickness In.	Total Ft.	Total In.
Surface	15		15		Coal and slate } Pittsburgh		10	306	
Shale, gray	15		30		Slate } Pittsburgh	1	1	307	1
Sandstone	4		34		Coal and slate } Pittsburgh	1		308	1
Shale, gray	8		42		Slate } Pittsburgh		4	308	5
Limestone	22		64		Coal } Pittsburgh	1		309	5
Shale, gray	14	6	78	6	Slate } Pittsburgh		10	310	3
Limestone	3		81	6	Bone } Pittsburgh		5	310	8
Shale, gray	2		83	6	Coal } Pittsburgh	6	4	317	
Limestone	1	6	85		Fire clay	4		321	
Shale, gray	1		86		Shale, light-colored	10		331	
Limestone	4		90		Limestone	6		337	
Shale, gray	10		100		Shale, gray	3		340	
Limestone	5		105		Shale, light-colored	10		350	
Slate, black	16	3	121	3	Limestone	5		355	
Sandstone	4		125	3	Shale, light-colored	20		375	
Limestone	32		157	3	Sandstone	4		379	
Shale, light-colored	7		164	3	Shale, light-colored	5		384	
Coal, Sewickley		9	165		Slate, black	4		388	
Shale, light-colored, sandy	8		173		Bone, Little Pittsburgh horizon	1		389	
Shale, gray	14		187						
Limestone	5		192		Fire clay	2		391	
Shale, light-colored	45		237		Limestone	4		395	
Shale, gray		9	237	9	Shale, light-colored	18		413	
Coal, Redstone	2	4	240	1	Shale, gray	15		428	
Fire clay	4		244	1	Limestone	6		434	
Shale, light-colored	34		278	1	Shale, light-colored	9		443	
Sandstone	6		284	1	Shale, red	48		491	
Coal, Pittsburgh rider		7	284	8	Shale, light-colored	11		502	
Shale, light-colored	20	6	305	2	Sandstone	2		504	

44. Westmoreland Coal Company's drill-hole—Concluded.

	Thickness		Total	
	Ft.	In.	Ft.	In.
Shale, light-colored	12		516	
Shale, gray	8		524	
Shale, light-colored	5		529	
Shale, red	7		536	
Shale, light-colored	2		538	
Shale, red	19		557	
Shale, light-colored	2		559	
Shale, red	2		561	
Shale, light-colored, sandy	20		581	
Slate, black	14		595	
Bone, Duquesne coal horizon		7	595	7
Shale, light-colored	10		605	7
Shale, red	7		612	7
Shale, light-colored	15	5	628	
Shale, red	23		651	
Shale, light-colored, sandy	22		673	
Shale, red	3		676	
Shale, light-colored	7		683	
Shale, red	16		699	
Shale, light-colored, sandy	31		730	
Shale, variegated	5		735	
Shale, gray	7		742	
Shale, red	3		745	
Shale, light-colored	1		746	
Shale, red	15		761	
Shale, light-colored, sandy	38		799	
Slate, black	2		801	
Limestone, Pine Creek	3		804	
Slate, black	4	6	808	6
Bone		6	809	
Shale, gray	2		811	
Sandstone	31		842	
Shale, dark, sandy	9		851	
Slate, black	18	6	869	6
Coal, Brush Creek		6	870	
Fire clay	16		886	
Shale, light-colored, sandy	18		904	
Shale, light-colored	10		914	
Sandstone	8	6	922	6
Shale, dark	9	4	931	10
Bone, Mahoning coal horizon		2	932	
Shale, light-colored, sandy	13		945	
Shale, dark, sandy	26	4	971	4
Bone and slate } Upper Freeport	1	4½	972	8½
Coal	2	11	975	7½
Slate		4¾	976	¼
Coal		10	976	10¼
Bone		1	976	11¼
Fire clay	3		979	11¼
Coal		7	980	6
Shale and limestone	16	6	997	
Shale, light-colored, sandy	11	6	1,008	6
Fire clay	4		1,012	6
Shale, light-colored, sandy	17		1,029	6
Sandstone	7		1,036	6
Shale, dark	18		1,054	6
Slate, black	2	8	1,057	2
Coal, Lower Freeport		6	1,057	8
Fire clay	9		1,066	8
Shale, light-colored	7		1,073	8
Sandstone	1		1,074	8
Fire clay	6		1,080	8
Shale, gray	9		1,089	8
Slate, black	17		1,106	8
Sandstone	5	6	1,112	2
Slate, black	6		1,118	2
Bone } Middle		2	1,118	4
Coal } Kittanning	3	7	1,121	11
Slate, black		6	1,122	5
Fire clay	3		1,125	5
Shale, light-colored, sandy	9		1,134	5
Sandstone	2		1,136	5
Shale, dark, sandy	7	7	1,144	
Slate, black	13		1,157	
Coal, Lower Kittanning	2	10	1,159	10
Fire clay, hard	3		1,162	10
Shale, light-colored, sandy	4	2	1,167	
Shale, dark, sandy	14		1,181	
Sandstone	51		1,232	
Shale, dark, sandy	21	6	1,253	6
Fire clay	4		1,257	6
Shale, gray	9		1,266	6
Slate, black	3	6	1,270	
Coal, Brookville		10	1,270	10
Slate, black		4	1,271	2
Fire clay	2	4	1,273	6
Slate, black	3	4	1,276	10
Conglomerate	44		1,320	10
Coal and slate } Upper Mercer	1	2	1,322	
Fire clay	1		1,323	
Shale, dark	3	6	1,326	6
Coal		8	1,327	2
Shale, dark, sandy	10		1,337	2
Slate, black	14		1,351	2
Fire clay	1	6	1,352	8
Shale, dark, sandy	54	4	1,407	
Fire clay	1		1,408	
Slate, black	3	4	1,411	4
Coal, Sharon		8	1,412	
Fire clay	12		1,424	
Shale, dark	13		1,437	
Fire clay	4		1,441	
Shale, green	13		1,454	
Shale, red	2	6	1,456	6

Total depth 1456 ft. 6 in.

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[PENN]SYLVANIA DEPARTMENT OF INTERNAL AFFAIRS
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GEORGE H. ASHLEY, STATE GEOLOGIST

TOPOGRAPHY

Base from U. S. Geological Survey topographic map of Pittsburgh quadrangle, Pennsylvania
Surveyed in cooperation with the Commonwealth of Pennsylvania in 1903–1904

MAP OF THE PITTSBURGH QUADRANGLE, PENNSYLVANIA

City streets extended from maps of City Engineers 1926

Scale $\frac{1}{62500}$

4 Miles

5 Kilometers

Contour interval 20 feet
Datum is mean sea level

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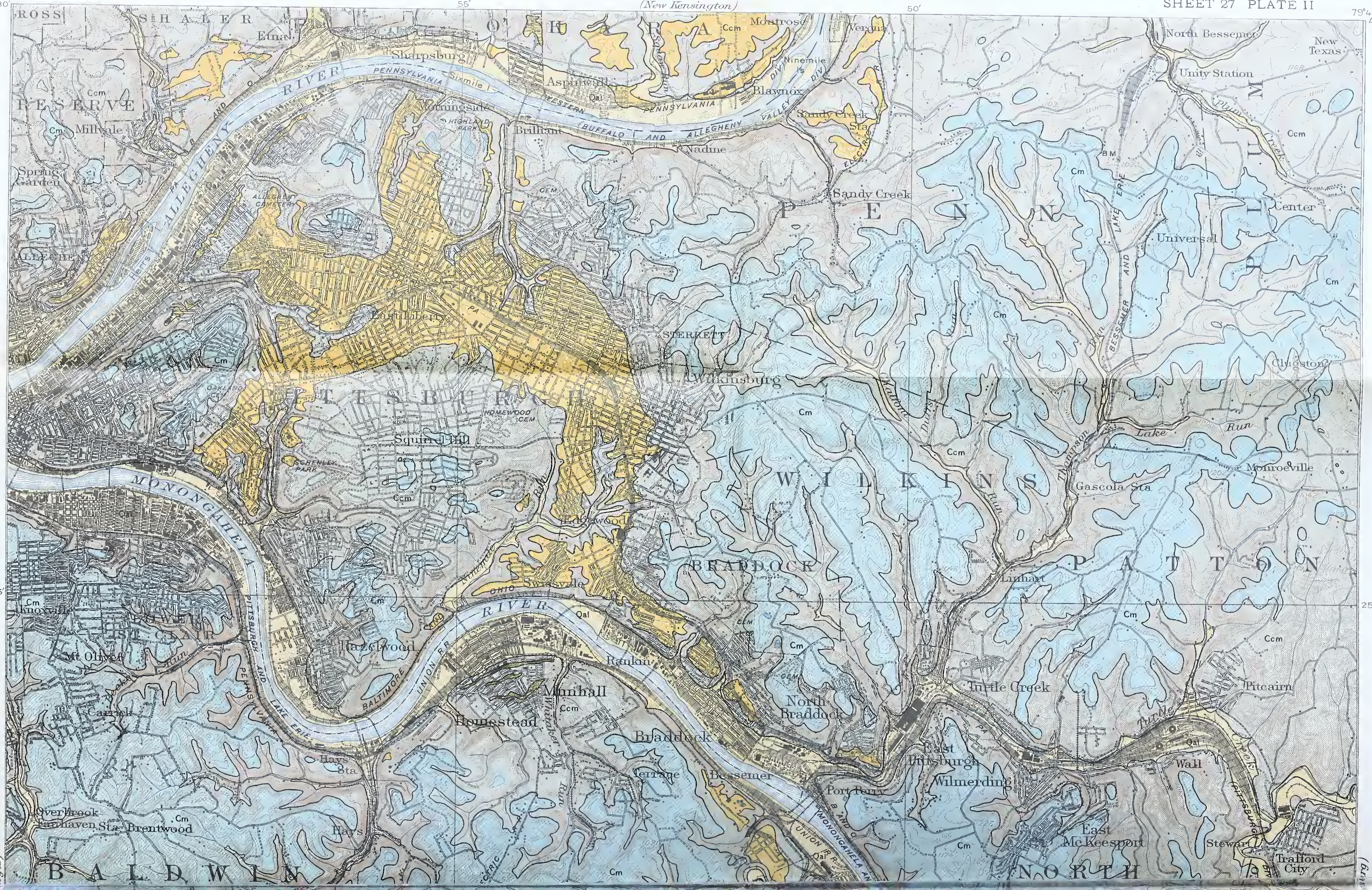
TOPOGRAPHIC AND GEOLOGIC
ATLAS OF PENNSYLVANIA
PITTSBURGH QUADRANGLE
SHEET 27 PLATE II

AREAL GEOLOGY
(New Kensington)



EXPLANATION
SURFICIAL ROCKS

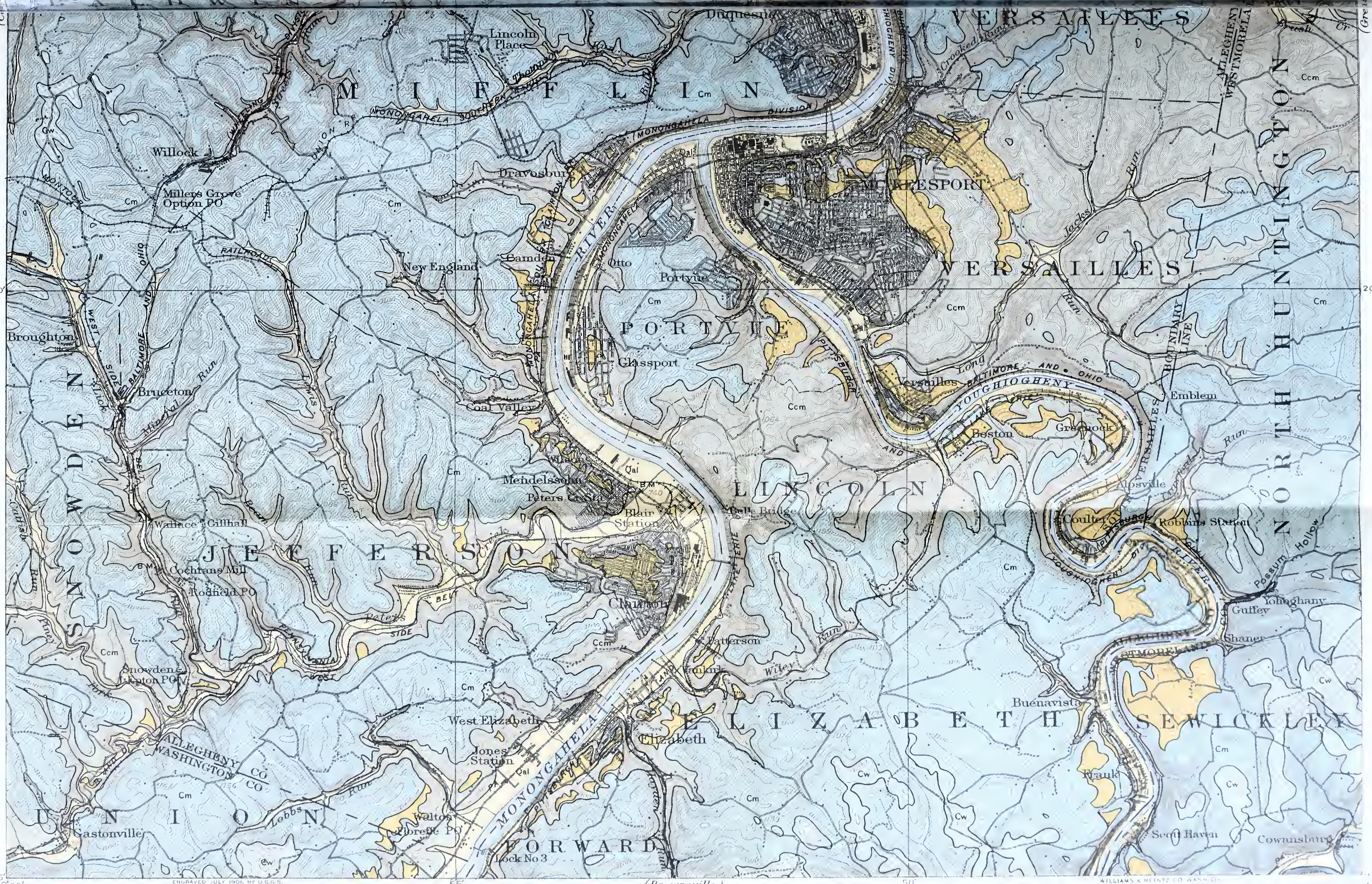
Qal — **Alluvial**
(in flood plains of present streams)

Terrace deposits
(sand and gravel on benches and in abandoned channels, deposited during glacial ponding of rivers)

Cw — **Washington group**
(sandstone, shale, limestone, and shaly coals; lower half only of formation is present)

Cm — **Monongahela group**
(chiefly shale and limestone, sandstones occasionally prominent; Waynesburg coal at top, Pittsburg coal at base)

Ccm — **Conemaugh group**
(shale and sandstone, thin coals and limestones; several fossiliferous horizons)



ENGRAVED JULY 1906 BY U.S.G.S.

Base from U.S. Geological Survey topographic map
Surveyed in cooperation with the
Commonwealth of Pennsylvania in 1903-1904

(Brownsville)

Scale $\frac{1}{62500}$

Miles

Kilometers

Contour interval 20 feet
Datum is mean sea level.

1928

Geology by M. E. Johnson
O. G. Bell, and C. J. Campbell
1921-1925

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MINERAL RESOURCES

TOPOGRAPHIC AND GEOLOGIC
ATLAS OF PENNSYLVANIA
PITTSBURGH QUADRANGLE
SHEET 27 PLATE III

EXPLANATION

OUTCROP LINES

Waynesburg coal

Base of Benwood limestone

Redstone coal

Pittsburgh coal

Ames limestone

Coal outcrops are shown only where coal is two feet or more thick

QUARRIES

- ⚒ Active quarry
- ⚒ Abandoned quarry
- Ls Limestone
- Ss Sandstone
- Sh Shale
- Cl Clay
- B Benwood
- S Sewickley
- P Pittsburgh
- C Connellsburg
- Cbg Clarksburg
- M Morgantown
- B Birmingham
- Sb Saltsburg

MINES

- ⚒8 Large commercial mine
- × Abandoned mines, country banks, prospect entries, manways, etc.

LIST OF MINES

1. Beatty
2. Harper No. 1
3. Union Valley No. 1
4. P. T. C. No. 4
5. P. T. C. No. 6
6. Gould

8. Henderson No. 2
9. Montour No. 8
10. P. T. C. No. 7
11. Blaine
12. Patterson
13. Lovedale
14. Yough No. 2
15. Ocean No. 2
16. Shaner
17. State Road No. 1

Shaft to coal bed

Diamond drill-hole, record given in text

Structure contours on base of Pittsburgh coal bed
Contour interval 25 feet
Datum is mean sea level

Note: Terrace deposits from which sand gravel are obtained are shown on Plate II, Areal Geology

Base from U.S. Geological Survey topographic map
Surveyed in cooperation with the
Commonwealth of Pennsylvania in 1903-1904

Scale 1/62500

Miles

Kilometers

Contour interval 20 feet
Datum is mean sea level

Geology by M. E. Johnson, O. G. Bell and C. Campbell

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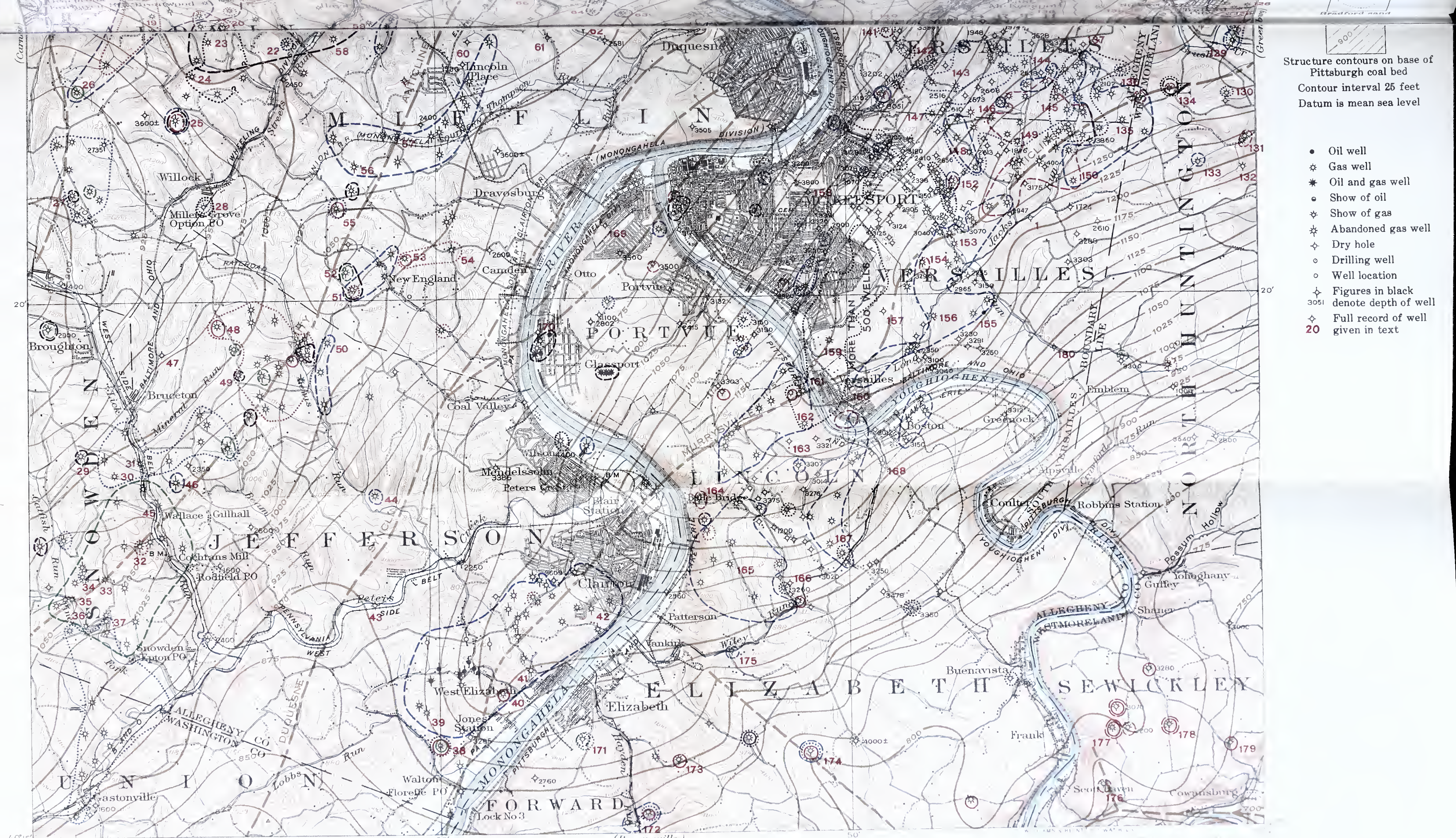
OIL AND GAS

(New Kensington)



Base from U.S. Geological Survey topographic map of Pittsburgh quadrangle, Pennsylvania
Surveyed in cooperation with the ...lth of Pennsylvania in 1903-1904

Structure and well data by M. E. Johnson, 1927

(Brownsville)

Scale 62500

Contour interval 20 feet
Datum is mean sea level